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The basic purpose of the project reported in this publication was to provide designs and new space concepts for facilities which would make optimum use of the new instructional aids and media. Basic tasks were to define the design criteria which would provide an atmosphere most conducive to learning and to then illustrate the criteria by a number of design studies which would explore solutions for a rather wide range of situations.

The studies presented were not intended to serve as "standard plans" but as guides in the planning of facilities that might be contemplated in colleges and universities.

During the course of the project, educators, architects, engineers, and equipment specialists participated in working conferences. In addition, special consultants in various technical fields were retained to advise the project staff, and an advisory committee assisted the staff in determining program requirements for design and methods of carrying out the objectives of the project.

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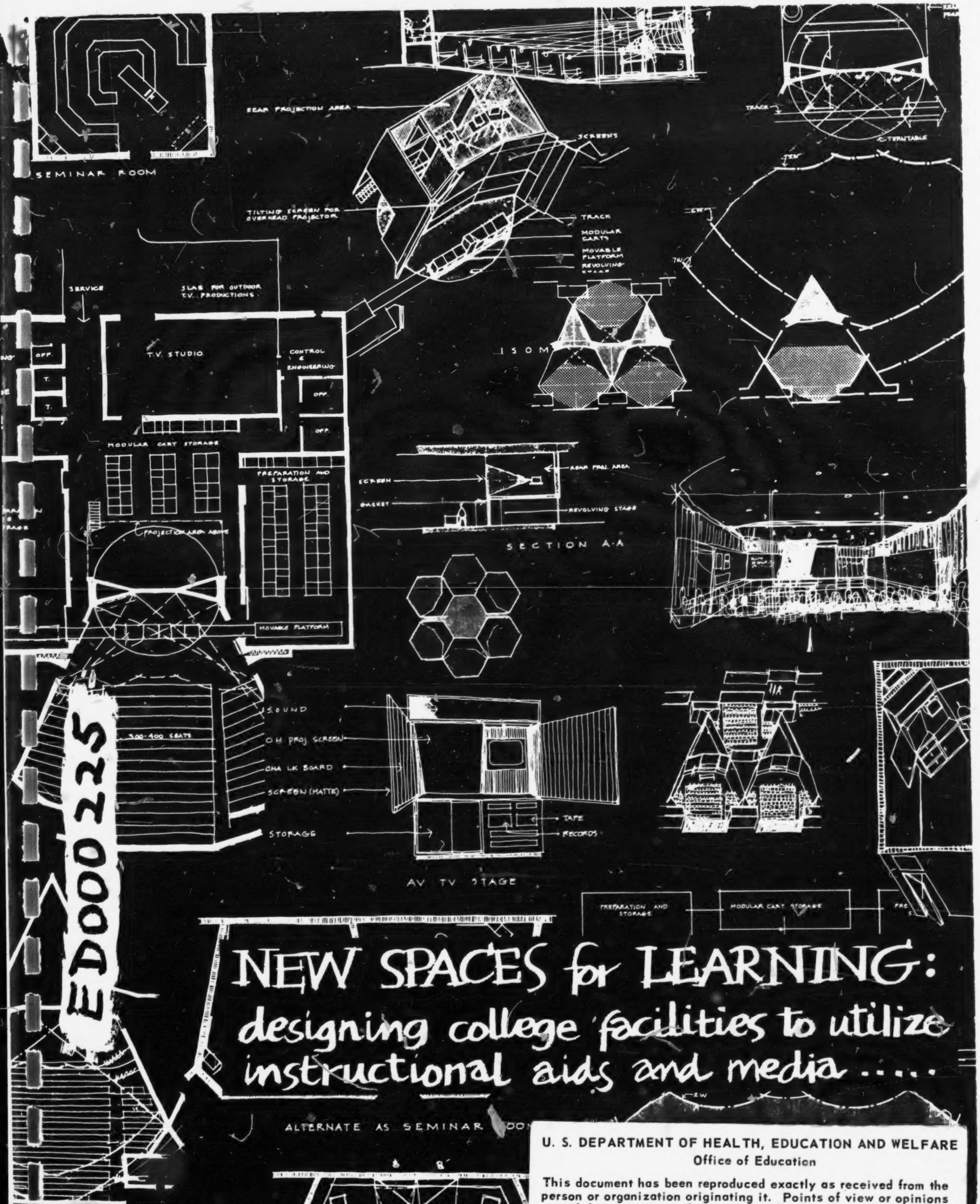
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REAR PROJECTION AREA
SCREENS
TILTING SCREEN FOR OVERHEAD PROJECTOR
TRACK
MODULAR CARTS
MOVABLE PLATFORM
REVOLVING STAGE
TRACK
TURNTABLE
SERVICE
SLAB FOR OUTDOOR T.V. PRODUCTIONS
T.V. STUDIO
CONTROL & ENGINEERING
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MODULAR CART STORAGE
PREPARATION AND STORAGE
PROJECTION AREA ABOVE
MOVABLE PLATFORM
ISOM
SCREEN
GASKET
REAR PROJ. AREA
REVOLVING STAGE
SECTION A-A
300-400 SEATS
SOUND
OH PROJ SCREEN
CHALK BOARD
SCREEN (MATTE)
STORAGE
TAPE
RECORDS
AV TV STAGE
PREPARATION AND STORAGE
MODULAR CART STORAGE
ALTERNATE AS SEMINAR ROOM

# NEW SPACES for LEARNING:
## designing college facilities to utilize instructional aids and media ....

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## A NOTE TO THE READER

We are all besieged with reports, many of which go unread for lack of time and their overwhelming volume. To assist any such harried readers of this report, it is suggested, if time is limited, to first read the synopsis of design criteria found at the beginning of Part III. These criteria are discussed in more detail in Part II, and are illustrated by the Design Studies throughout the rest of Part III. Of course, if possible, we would advise starting at the beginning and reading the report in its entirety.

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. . . . the optimum use of instructional aids and media requires new concepts of space types and their design . . . .

# NEW SPACES FOR LEARNING - designing college facilities to utilize instructional aids and media

Report of a Research Project
Conducted by the
School of Architecture
Rensselaer Polytechnic Institute
Troy, New York
June 1, 1961

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The project was supported by a grant from the Educational Facilities Laboratories, Inc., and carried out under the code name "Project DASFEE": Design of Auditorium-Studio Facilities for Engineering Education.

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Part III - Design Studies - Learning Spaces

**. . . . a series of drawings with accompanying text illustrating the design criteria discussed in the report, and representing a range of capacities and functions . . .**

# FOREWORD

The basic premise of this report is that "the optimum use of the new instructional aids and media requires new concepts of space types and their design". These devices have been developed to assist in providing a high quality of instruction while endeavoring to meet the demands of increased enrollment. When television and projected materials are to be used as a substantial part of the teaching-learning process, different concepts of optimum environment are required than when visual aids are used only occasionally.

The purpose of this report then, is to assist in developing optimum environments by defining the design criteria which will provide an atmosphere most conducive to learning. In turn, the design criteria are illustrated by a number of design studies which explore possible solutions for a rather wide range of situations.

The studies are in no sense "standard plans" but are intended to serve as guides in the planning of facilities that may be contemplated in colleges and universities. Although the possible relationship between space requirements and educational programs has been given due consideration, the schemes presented are not based on any particular educational philosophy.

During the course of the project, educators, architects, engineers, and equipment specialists participated in working conferences. In addition special consultants in various technical fields were retained to advise the project staff. To give breadth to the study an advisory committee composed of representatives from Case Institute of Technology, Georgia Institute of Technology, Southern Methodist University, Stanford University and Rensselaer Polytechnic Institute assisted the project staff in determining program requirements for design and methods of carrying out the objectives of the project. All of these Institutions have carried on experimental work in connection with classroom television or other technical instructional aids. A roster of the many persons who participated in the Project follows Part III.

Although the original project was concerned primarily with design of facilities for effective teaching of concepts in engineering education, this report should have wide application in many disciplines where aids and media are employed in the instructional process.

Funds to cover the cost of the project were provided by a grant from the Educational Facilities Laboratories, Inc. Rensselaer's School of Architecture is deeply appreciative of this support and of the cooperation and interest of all those who participated in the study.

HDH
WFK
ACG
MCG

June 1, 1961

# PART I

# INTRODUCTION

# PART I

# INTRODUCTION

Prior to discussion of design factors and presentation of the design studies, it will be desirable to develop the background and define the scope of this report. This may be accomplished by answering the following four questions:

What are the urgencies that have prompted the application of aids and media in higher education?

What is meant in this report by the "aids and media"?

In terms of facilities, what is the problem for which this report will develop approaches for solution?

What are the basic premises on which this report is based?

## THE URGENCIES

Five factors of urgency can be identified as creating the need for the development and application of modern technology in higher education.

a) Rapidly expanding enrollments. Education in America is moving rapidly in the direction of providing an appropriate education for all citizens regardless of their socio-economic status or age. By 1970 college enrollments are expected to double those of 1960.

b) Shortage of faculties and facilities. The demands for education and training made on colleges and universities have not been met by an equivalent expansion of faculties and facilities. The high cost of facilities, particularly those required for science and engineering, have confronted institutions with the dilemma of needing, but not being able to pay for enough, new buildings.

c) Desire for a higher quality of education. Education is being called on to do more things: encourage students to develop their full potentials and broaden the competencies and raise the attainment levels of all college graduates. These demands exist within a social context of increased occupational and professional specialization, and with an increasing emphasis on science and technology.

d) Need for improving the organization and presentation of knowledge. The amount of information that college students, and particularly engineering and science students, are expected to acquire in order to prepare for their professions is enormous. Methods of organizing and expediting the presentation of this massive body of knowledge, while still encouraging the process of assimilation and application, is a major challenge to contemporary education.

e) Increased emphasis on education. Education has become an acknowledged requirement for survival in today's scientific and technical competition for national positions. Suddenly the entire population is concerned with education at all levels.

These urgencies working together have prompted higher education to explore the use of the aids and media in order to improve the quality and increase the quantity and efficiency of learning. Depending on the particular situation, institutions are employing the aids and media for different reasons, or more often, for a combination of reasons or urgencies.

The use of aids and media is admittedly not the only way to meet the problems and challenges of higher education. Year-round sessions, development of the community college, and greater sharing of facilities among institutions all have the same objective.

## THE AIDS AND MEDIA

Instructional aids and media, often referred to as audio-visual aids, are devices that present or assist in presenting instruction and encourage learning responses.

If used simply to assist a professor in the teaching-learning process by presenting supporting material, usually intermittently, they are referred to as instructional aids. If, on the other hand, the devices present a complete body of information, they are considered to be media. The chief distinction, then, lies in the extent to which the device or system of devices carries the burden of instruction; a medium is largely self-supporting, while an aid serves to supplement the instructor's presentation. Obviously, depending on their manner of use, some devices may be either aids or media.

This report is essentially a "building-type study," and as such, the primary concern is with spaces and their design. Therefore, in discussing the instructional aids and media, we have been concerned principally with those that affect space design. These include:

- Projection devices
    - motion pictures, film strip, slide, overhead, opaque, and shadow
- Non-projection devices
    - large scale models, demonstrations, apparatus, audio recordings, radio, and teaching machines
- Television

In spaces for learning, the principal design concern is with student relationships to the aids and media - how he can best see, hear and react - and the accommodation of the equipment to achieve these responses. Many times a system of devices is involved and their joint, rather than individual, functions may govern. The design of facilities for the supporting functions of origination, production, distribution and recording must also be considered.

## THE PROBLEM

Relatively little has yet been done to provide appropriate spaces in which to employ these techniques of instruction to their full advantage. Except for a few isolated cases, they are generally being used in makeshift environments - in rooms not planned for the purpose, though benefitting perhaps from certain essential "improvements". Design of the spaces for learning has not kept pace with the development of instructional and learning methods, yet the new techniques have generally proven successful in spite of this.

Hundreds of new schools are being built today, ostensibly to take full advantage of the most advanced teaching methods, but their plans only occasionally reflect this by the nature of the spaces provided. Classrooms still follow the typical pattern dictated by long-established conventional uses. Happily there are a few exceptions, but their proportion to the total by no means reflects the prevalence of new concepts in educational methods.

Within the past few years the impact of the new aids and media on education at all levels has been the subject of extensive discussion. Primary interest has centered on questions of pedagogy, educational philosophy, and the effectiveness of the new techniques. Little attention has been given to solving the architectural problems, perhaps because they have not been recognized. There is little doubt, though, that most of the instructional aids and media, television included, require specific environmental conditions for their most effective use. These conditions are not provided in conventional college classrooms and buildings.

## THE PREMISES

This report is based on three premises which define its scope and direction.

> Visual and aural aids and media, including television, will play an increasingly important role in education.
>
> > There is no intent to examine, or justify this approach to education. Instead it is assumed that its merits have been sufficiently established and that the important question now is how to design appropriate physical facilities to accommodate the aids and media.
>
> The primary concern is the design of those specific spaces which accommodate the aids and media.
>
> > Within these limits two principal types of space are involved:
> > a) Spaces for instruction and learning.
> > b) Spaces for production and origination.

Just which and how many of these spaces will be used, and what will be their proportion in relation to other facilities, will be determined in each situation by policy and budget considerations. The design studies aim to offer, in effect, a series of special "building blocks", from which to select those which may fit appropriately into the whole complex whether it be a single building or an entire campus.

### Proper design of these spaces does not depend on the dictates of a specific educational philosophy.

Educational philosophies will be considered, but only in respect to their common influences on design. There will be no attempt to urge specific philosophies. Nevertheless, it is recognized that in their application to a given situation the concepts offered must be moulded to conform with the governing educational specifications.

# PART II

# FACTORS IN DESIGN

A. Background for Planning

    1. The aids and media
    2. The use of space

B. Learning Spaces

    1. Character
    2. Shape
    3. Image viewing
    4. Projection methods
    5. Lighting
    6. Acoustics
    7. Mechanical equipment
    8. Equipment and fixtures
    9. Examples of existing facilities

C. Production Facilities

    1. Instructional materials production
    2. Television production
    3. Combined production
    4. Examples of existing facilities

D. Instructional Materials Access Center

# PART II

# FACTORS IN DESIGN

## A. Background For Planning

Several different types of space are necessarily involved in the overall provision for optimum use of instructional aids. In this report the primary concern is with the "learning spaces", because it is these spaces which seem to be most in need of architectural attention.

Facilities for production are obviously of equal importance in the total concept. Their requirements are more technical than architectural, so that within the scope of this report the chief concern has been only to clarify the functional aspects of these requirements, rather than their architectural character.

A third type of space, also essential to any well-rounded program, is that which provides a library function for instructional materials - the "materials access center." The vital importance of such facilities is also recognized, but this report deals only with the general character of their requirements.

Before examining in some detail the factors in the design of these three different types of space, it is essential to review briefly some considerations common to all. These considerations might be called "Background for Planning" and cover:

a) potentials of the aids and media.
b) concepts regarding the use of space.

Background for Planning

1. The aids and media -

   1) Feasibility

   A large number of studies have been made toward exploring the educational feasibility of instruction by television, as well as many of the other newer instructional devices. The results have indicated there are usually no substantial differences in learning between the new methods and "conventional" methods.

   Of particular significance is the fact that the feasibility studies have been conducted in converted, conventional, or often inadequate spaces. If the results are encouraging under such conditions, the aids and media should be more effective in spaces particularly designed for their optimum utilization.

Two points are important when discussing economic feasibility of the aids and media:

1. Economic feasibility is directly related to the number of students enrolled in a given course. For instance, usually at least 200 students in a course are necessary before televised (vidicon equipment) instruction becomes economically comparable with conventional methods.

2. A careful cost analysis must be made for each installation to determine its economic feasibility. Factors of equipment, type, and cost; faculty salaries; renovation of facilities; maintenance; and courses and methods all vary with each situation. Based on such an analysis, a break-even point between televised (or any method utilizing the instructional devices) and conventional instruction can be determined.

2) Obstacles

It may appear that the development and application of the aids and media in education has been a relatively easy evolutionary process, depending simply on finding the most appropriate ways and means. Such has not been the case, as the following points indicate.

1. Equipment has not been developed for educational uses. As is often the case, equipment was first commercially developed for industrial and home use, and education has attempted to adapt this equipment to its own needs. Education must define its needs; manufacturers cannot be expected to anticipate them.

2. Much equipment is complicated and not sufficiently dependable.

3. Development lacks coordination. The development of the aids and media has to a large extent been uncoordinated and segmented with one group advocating films, another TV, and yet another large scale models and demonstrations. The result has been "audio-visual cults", each a proponent of one technique to the exclusion

of others. No one technique is the only answer to all instructional situations. Also contributing to this segmented development is the lack of integrated equipment.

4. Costs are high.

5. Objective attitudes and additional research are lacking.

3) Future Developments.

The greatest challenge to any designer or architect is the necessity of forecasting and anticipating the future needs a building is expected to fulfill. Likewise in the planning of educational facilities, probable changes in educational philosophies, methods and equipment must be anticipated. The following list indicates only a few of the possible developments in equipment. How they will affect the design of space is the concern of the future.

1. The transmission of high fidelity, stereophonic sound, synchronized with motion picture and television images.
2. The connection of individual and class viewing screens with centralized resources to permit showing books, films, documents, etc. on demand.
3. Easy accessibility to resource material in miniaturized form.
4. The making of recordings of groups of students or individual students from the students' desks.
5. The use of "museum-type" displays of materials as an instructional aid.
6. Modular approach to the design of instructional system components, permitting growth and development of the system.
7. Large, flat wall-mounted television receivers unhampered by tube design, but based on a wire-sensitive grid.
8. Development of economical color television.
9. Integration of equipment into single, easily-operated mechanisms that are capable of multi-interchangeable functions.
10. Remote-controlling of all apparatus.
11. Pre-programming of instructional aids coupled with lighting, air-conditioning, sound, and other display areas and equipment.

## 2. The use of space

### 1) Large groups

Educators have been finding that large group instruction and instructional efficiency may be directly related. Because of this more concern has been given to the physical accommodation of large groups, both in existing conventional school plants and new facilities.

By employing television a large group may meet in a series of small rooms interconnected by sound and video cable. Also the large group does not necessarily need to meet simultaneously, as films, video tapes or kinescopes can be repeated several times to segments of the large group.

In the planning of new facilities, the trend toward large groups implies the need for a variety of large learning spaces with means of interconnecting these larger spaces with small seminar-type spaces and existing conventional classrooms.

### 2) Utilization Rate

As the demands on educational facilities intensify, institutions are very carefully analyzing their space utilization. The details of analysis vary, but generally it is based on the percentage of use of total student stations (seats, laboratory stations, etc.) per 40 or 48 hour week. The results have been startling. It appears that actual utilizations of 50 to 60 percent are high; some are less than 10 percent. Consequently it often becomes difficult to justify the building of new facilities when those existing are not used efficiently.

Again the use of the instructional aids has been one approach to the problem. As an example, when television is used as a medium, spaces which have been too small for large groups can be tied together and one large class may be scheduled into a number of spaces of various types and sizes. Thus coaxial cable, tapes and films are making the walls separating classrooms less an obstacle to accommodating multiclass sections and by helping to increase the utilization of existing spaces, the demands on facilities may sometimes be met without requiring new construction.

### 3) Evolution

The development of spaces in which the aids and media are employed is oftenan evolutionary process with three distinct stages:

1. Conversion of existing spaces. - typical retangular classroom adapted by including "light tight" window blinds, black-out curtains, a roll-down or portable screen, and possibly a TV monitor in the front corner near the window. Such conversions have worked, but not well - the room is completely darkened

for projection, the projector must be brought in and set up with accompanying disturbance, there may be glare on the monitor, and generally the space itself does not support the use of the instructional aids.

2. Conventional spaces with provisions for the aids and media. - designed to include control of natural light and ventilation, permanent or easily portable projection stands and screens, coaxial cable and communication lines, jacks for TV reception, a predetermined location for the monitor, and a lighting system that will cause less glare. These spaces indicate a transition in philosophy of use - "We will use the aids some, and maybe more in the future as their value is proven, but in the meantime we are more concerned with conventional spaces."

3. New spaces designed specifically for the utilization of the aids and media. - designed to support in every possible way the inclusion and utilization of the aids and media. The design reflects a positive stand - "We've tried the aids, their values have been shown, and now we want spaces that can best function to produce optimum educational results." These are the spaces about which this report is primarily concerned.

During the current period of transition, these stages of evolution are represented to varying degrees on most college campuses in the country. It is a healthy sign; an indication of experimentation and gradual acceptance. But once the decision has been made to use the aids and media, it should no longer be necessary to experience this evolutionary process. It is only in the best planned spaces that their educational merits can be fully realized.

4) Flexibility

No other concept in the planning and design of educational facilities is receiving as much attention or implies such variety of meaning to different people as "flexibility". It is one of those elusive terms applied to a concept that everyone favors, but few can agree as to its value, its significance, or how best to achieve it.

There are several approaches to providing flexibility, and each has its proponents. To evaluate them objectively, requires an analysis of the specific objectives, the time limitations, and the inherent problems involved. To begin with, the need for flexibility is attributable to three factors:

1. Variations in teaching material and techniques - instructional methods are not only changing but increasing in number, as new ways are developed to better serve the learning processes. The different aids and media require different environments, equipment and arrangements for their optimum use, thus increasing the variety of space functions required.

2. Variations in class size - The long-accepted ideal of fewer than 30 students in a class is no longer sacred. Instead, present concepts of the best educational methods call for a wide variety of space sizes to accommodate not only individual study, but groups ranging in size from the small seminar to the large lecture audience.

3. The necessity of providing for future developments - The problem of planning so as to satisfy today's requirements, but with sufficient flexibility to accept, without prohibitively expensive changes, the techniques and equipment likely to be used tomorrow is the designers greatest challenge. It should be recognized that the buildings which house our educational needs will likely be more permanent than the character of those needs, and only by far-sighted anticipation of the probable nature of changes can early obsolescence be avoided.

Flexibility of space sizes and functions can be provided in either of two ways:

a) By changing the size and/or function of the space, or
b) By transferring the occupants from one space to another.

Considering first the variation in space functions to accommodate various instructional methods, the following table indicates how two basic methods of providing flexibility compare with respect to time limitations.

| time available for changeover | by rearrangement of furnishings and equipment | by transfer of occupants |
|---|---|---|
| between periods (1-5 min.) | In small spaces, limited to rearrangement of chairs and other light objects, In large spaces, demonstration area may be reset by revolving or slide-on platform. | permits complete change of environment and facilities regardless of time limitations. |
| between-days (1 hr. or more) | heavier furniture and equipment may be rearranged | |
| between-terms (several days) | extensive rearrangement possible | |
| between-years (several months) | complete rearrangement and furnishing can be accomplished | |

In determining how best to provide variety in space sizes, again two alternatives can be considered - change the size of the space, or transfer the occupants from one space to another. In the following table four types of partitions for changing the size of space are compared with the alternative of moving the occupants.

| time available for changeover | by partitioning methods | | | | by transfer of occupants |
|---|---|---|---|---|---|
| | operable | demountable | block or framed | glass and curtain | |
| between periods (1-5 min.) | suitable if motorized | not suitable | not suitable | suitable | only limitation is distance between s |
| between days (1 hr. or more) | suitable | possibly suitable | not suitable | suitable | any desired change can be accomplished |
| between terms (several days) | suitable | suitable | not suitable | suitable | |
| between years (several mos.) | suitable | suitable | suitable | suitable | |

The four partitions suggested vary greatly and should be comparatively evaluated on four points:

a) Time required for placement or removal
b) Sound transmission value
c) Design limitations
d) Cost

If a space or a number of spaces are designed to meet the requirements of a particular educational function, it becomes a real challenge to have them also support other functions well. It can be done, but usually with compromises and sacrifices. For higher education the provision of a wide variety of space types, capacities and equipment with flexibility achieved by scheduling of the spaces, appears a logical goal towards which to work.

### 5) Programming

The building program - a definition of required space types, functions, and relationships - forms the basis of any building design. In the design of educational facilities, the building program is based on the educational specifications which are prepared by the educators working with the institution's planning agency. No educational facility can ever be expected to function satisfactorily unless its design is based on thorough, complete and realistic educational specifications.

For example, in designing even a single space the educational specifications and in turn the building program should define:

1. The curriculum and subjects to be taught in the space.
2. The instructional methods to be used and the desired relationships between instructor and students.
3. The size of the group, the length of classes, and the desired utilization rate of the facility.
4. The equipment required.
5. Auxiliary spaces (storage, preparation, etc.).
6. Relationships with adjacent spaces, including access and circulation.
7. Special features.

With an adequate program, the architect can plan space to support the functions outlined; but if the programming phase is incomplete or unrealistic the resulting building may not completely fulfill its educational needs. When the use of aids and media is involved, the need for careful programming is of particular importance.

# FACTORS IN DESIGN

## B. Learning Spaces

### 1. Character

The fundamental consideration in any instructional space should be the provision of an atmosphere conducive to the teaching-learning process. It is the architectural character of the space that must provide this atmosphere. Chief among the factors which determine architectural character are shape, proportion, materials, lighting, color, and acoustics.

Additional factors influencing the character of the spaces discussed in this report are those imposed by optimum utilization of aids and media. These additional factors, we believe, necessitate a fresh design approach, divorced from the connotations of conventional teaching and the traditional classroom associated with it. To emphasize this concept the term classroom itself has been discarded, and instead we propose to examine the architectural character of the "learning space".

Teaching and learning, in the academic sense, always has and probably always will involve the activities of speaking, hearing, seeing, and writing. Progress in teaching methods has changed the relative emphasis on these activities with the result that seeing, or viewing, has become increasingly important over the years, as the use of visual aids has grown.

Before projected materials were employed, the objects to be viewed were the chalkboard, maps, charts, and the instructor himself. Generally these areas of visual attention were distributed about the room, and all of them received their illumination by the general lighting of the room itself. Since there was no fixed area of attention, sightlines and viewing presented no serious problems as long as general lighting was adequate.

As visual aids came into use the requirements for seeing changed. The projected image necessarily occupies not only a fixed position but a fixed plane, and can properly be viewed only within a limited area. Even more important, general room lighting competes with the image, weakening rather than strengthening the area of attention. Obviously as the use of such aids and media becomes a prime function of the space, optimum viewing of the projected image becomes a principal consideration in designing the room. Thus the character of the room may change radically.

As has already been indicated, learning spaces designed for utilization of the aids and media may cover a wide range of sizes, from seminar room to auditorium. All of these are properly considered learning spaces, but the specific functions of the rooms vary with the size of the group to be accommodated, the course material, and the particular instructional method employed.

## 2. Shape

Perception (viewing and hearing) or discussion are the two principal activities to be considered, particularly in the smaller learning spaces. Either may be the chief function. To best accommodate either one of these functions requires different seating arrangements and consequently different optimum room shapes.

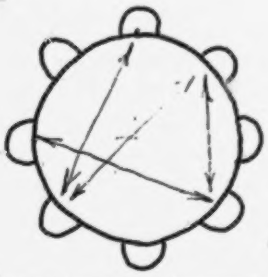
One of the basic premises in this study has been that even the smaller learning spaces should not be designed to accommodate a variety of uses requiring different seating arrangements, but should be planned for a specific purpose. The variety of uses required in a curriculum will be satisfied, then, by scheduling the use of various rooms, rather than by rearranging furnishings in the room.

The approach in considering the smaller learning spaces has been to propose two types of rooms - one in which the interchange between students is the principal concern, with the viewing of projected material perhaps serving as a stimulus or a complement to the discussion; the other, in which viewing and hearing are the prime activities, with supplementary discussion being supplied chiefly by the instructor.

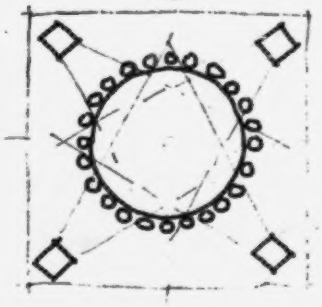
These two functions differ distinctly, as will be indicated, in their planning implications. In the former case, which will be referred to as the "seminar room", the occupants are participants, and their attention and interests are inter-oriented; in the "viewing room", though, the occupants are essentially spectators constituting an audience, and the interest is teacher-oriented.

In all the learning spaces the ideal seating area with respect to both the intended activities and the aids to be used, is the primary consideration. The theoretically ideal room shape, then would be that which most efficiently encloses the aids and their optimum viewing area, along with ample circulation space. Often, though, this "ideal" shape is impractical when cost of construction and efficient overall building arrangement is considered. A practical solution may require compromise, and the shape resulting may only approach the theoretical ideal.

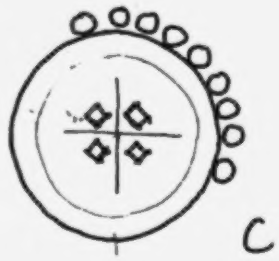
For the smaller seminar group not concerned with the use of visual aids, probably the ideal arrangement is the round table, permitting each participant to face most of the others, as indicated in Sketch A.


A.

When the use of visual aids is introduced, however, the round table arrangement has very definite limitations and disadvantages. It becomes necessary either to have a number of "copies" of the images being viewed, or to require many of the participants frequently to turn around in their seats.


B.

If TV is employed, the necessary duplication of images can be accomplished, - at a price - by using a number of monitors. Four monitors, for instance, might be located in each corner of a square room, as in Sketch B, serving the participants seated in the opposite quadrant of the circle; or a cluster of four or more monitors might be suspended at the center of the group, as suggested in Sketch C.

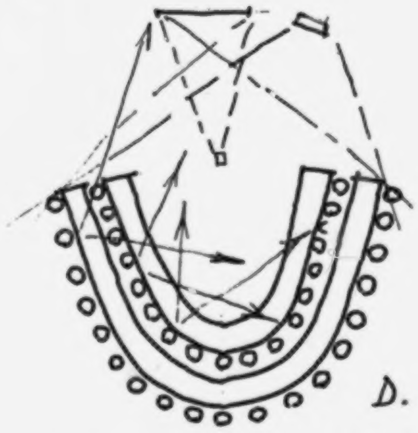


4 monitors suspended above head height

C.

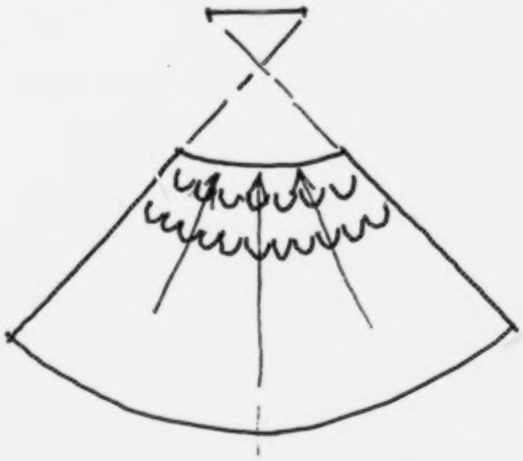
Either of these arrangements is difficult to justify economically, since each monitor serves only a few participants, and the room area required per student is excessive. A greater disadvantage is that the use of other types of projected materials is difficult because of the cost involved in duplicating screens and projection equipment.

Some other arrangement is, therefore, preferable in order to provide in the seminar nrooms, not only TV, but projected images. The arrangement must minimize the amount of equipment needed, make more efficient use of room space, and at the same time locate the seating so that interchange between participants is encouraged. It would seem logical, with these objectives in mind, to use a generally semicircular or semi-elliptical seating arrangement, perhaps in two rows, with the screen and TV monitor at the open side, as indicated in Sketch D.



D.

In the teacher-oriented spaces, on the other hand, where attention is generally directed to one area and interchange between students is of secondary concern, the projected image becomes the focus of attention. Optimum viewing areas, as determined by the size of the image, define the useful seating area and all seats face toward the image or images. It becomes apparent that the plan shape of enclosure best fitting this complex is roughly a segment of a circle. This form is not necessarily the best choice in all cases. If the room is relatively small and must be efficiently combined with other rooms, considerations of cost may dictate a simpler form, while for a large auditorium the segmental form is often satisfactory.



## Learning Spaces

Except for the smaller rooms, where inter-oriented discussions may be the governing consideration, all learning spaces in which visual aids are to play an important role, should have, as the chief determinant of their plan shape, this consideration of the optimum viewing area. As the number of occupants increases, the size of the screen (and image) increases accordingly, but the same principles apply in all cases.

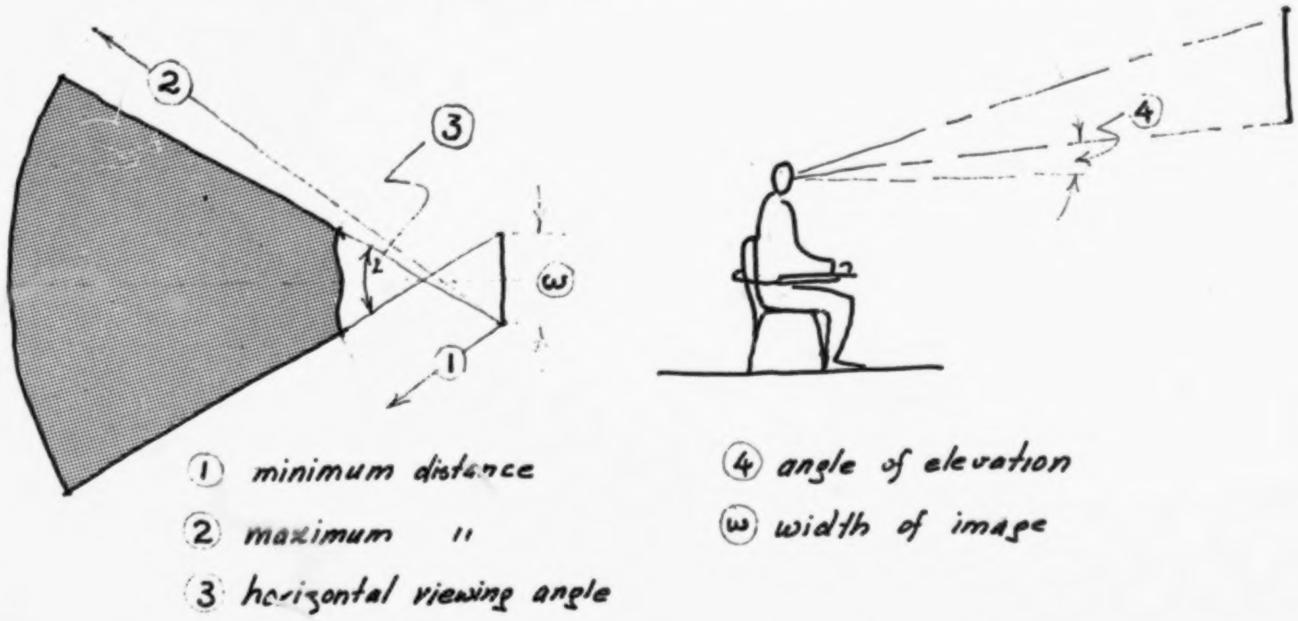
It must be kept in mind that the shape of a room is a volume rather than simply an area in one plane. Heights and sectional profiles are equally as important as the shape and dimensions of the plan. The elevations of sight lines deserve as much attention as their angles in plan.

If ideal viewing conditions were the only consideration, there is no doubt that the floors in all rooms should be stepped or sloped to some degree. Here again practical considerations usually dictate a compromise, and, unless cost is no consideration, it is doubtful that the ideal should govern in all cases. Stepped or sloped floors should generally be considered essential in learning spaces planned for fifty or more students. In rooms smaller than this, other considerations may outweigh the advantages of stepped flooring. Among these considerations are the original cost involved and the obstacles raised to future conversion of the spaces to other uses or arrangements.

## 3. Image Viewing

The definition of the viewing area is a function of the size of the image, whether it is projected on a screen or a monitor tube. Conversely the size of the image is a function of the viewing area. These relationships are defined by four dimensions:

1. Minimum distance: the distance from the nearest part of the image to the eye of the closest viewer.
2. Maximum distance: the distance from the furthermost part of the image to the eye of the most distant viewer.
3. Horizontal viewing angle: the total horizontal angle which defines the sides of the viewing area.
4. Angle of elevation: the maximum angle between the horizontal line of sight and the line of sight to the bottom of the image, as seen by the nearest viewer.



In addition several factors must be considered when determining what dimensions to consider as valid for defining a viewing area.

1. Type of material to be viewed: color or black and white; contrast between symbols and background; size of figures and symbols; and other basic legibility requirements of perception.

2. Length of presentation: (Although research has not produced specific governing rules, it is well known that the duration of time a student is required to focus his attention on a particular image, the better must be the viewing conditions to prevent fatigue. It appears that for long presentations the most critical dimension is the angle of elevation, especially if note-taking is involved.)

3. Factors of environment: lighting, color acoustics, temperature, ventilation, seating type and arrangement.

4. Characteristics of equipment: brightness of image based on light output of projector or monitor; screen type and viewing characteristics; design of monitor face; quality of accompanying sound, and other factors inherent in the equipment.

## Legibility Standards

For material containing letters, numerals or other symbols, certain standards of legibility have been established to insure their being readily perceived when projected.

1. Size: [1] for black and white line subjects the smaller projected symbols must subtend an arc of not less than 9 minutes with the viewer. Then:

| if the greatest viewing distance is | the minimum symbol size* is |
|---|---|
| 8 feet | ¼ inch |
| 16 " | ½ " |
| 32 " | 1 " |
| 64 " | 2 " |
| 128 " | 4 " |

*height of the body of the type.

2. Symbol design and line weight: symbols equivalent to a sans-serif medium weight face of normal proportions should be satisfactory. The thinnest line should be at least ½ the thickness of the vertical lines of type (descenders).

After establishing the minimum size of symbol to be seen by the viewer, this must then be proportioned according to the size of the original material (2 x 2 slide, 10 x 10 slide, etc.)

Regardless of the material or method of displaying it, the standards of legibility are the same for a given space. If for instance, the most distant seat requires minimum symbol size of ½", it must be ½" whether projected on a screen by a slide, film or over-head projector, or seen on a TV monitor. This then indicates that the production process (the making of the film or slide, or the television origination) is also a factor of viewing.

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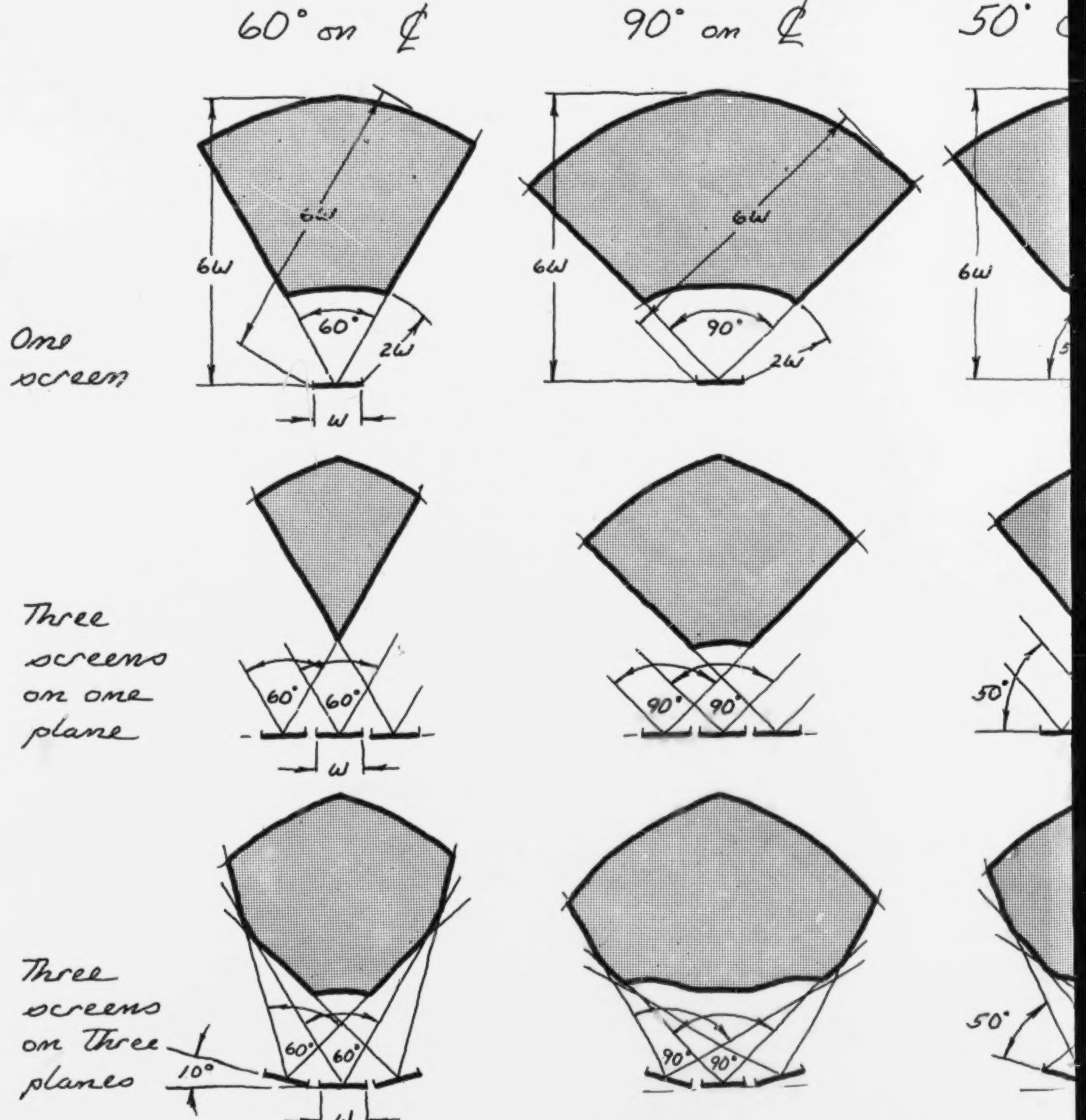
[1] Based on material published by the Eastman Kodak Co., Rochester, N. Y.

Section 1

# Viewing A

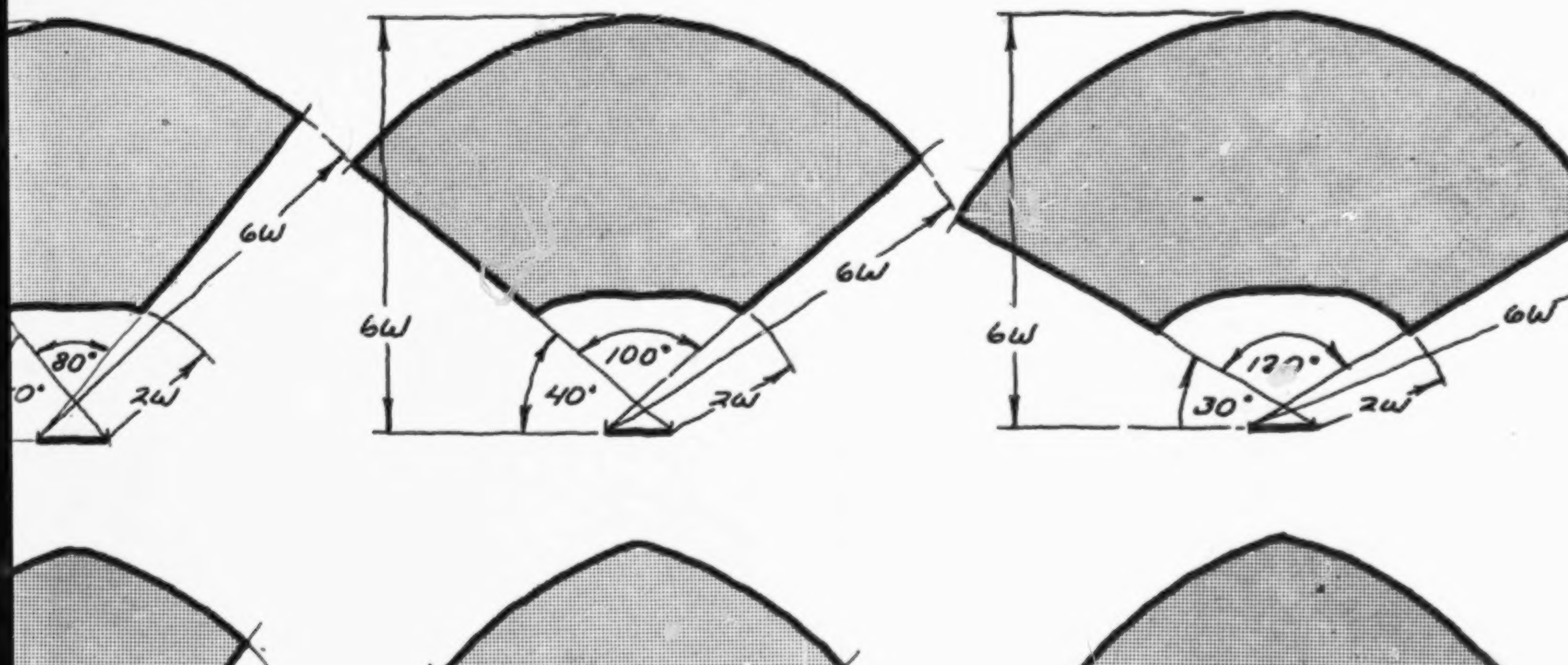
Maximum distance = "6W" Minimum distance - "2


60° on ℄
90° on ℄
50°
6W
6W
6W
6W
6W
6W
60°
90°
2W
2W
W
One screen
Three screens on one plane
60°
60°
90°
90°
50°
W
Three screens on Three planes
10°
60°
60°
90°
90°
50°
W

# reas

W" Width of Image = "W"

Edge Angle 40° Edge Angle 30° Edge Angle


6W
80°
2W
6W
6W
100°
40°
2W
6W
6W
120°
30°
2W
80°
40°
100°
120°
30°
80°
100°
40°
120°
30°

## Projected Image Viewing

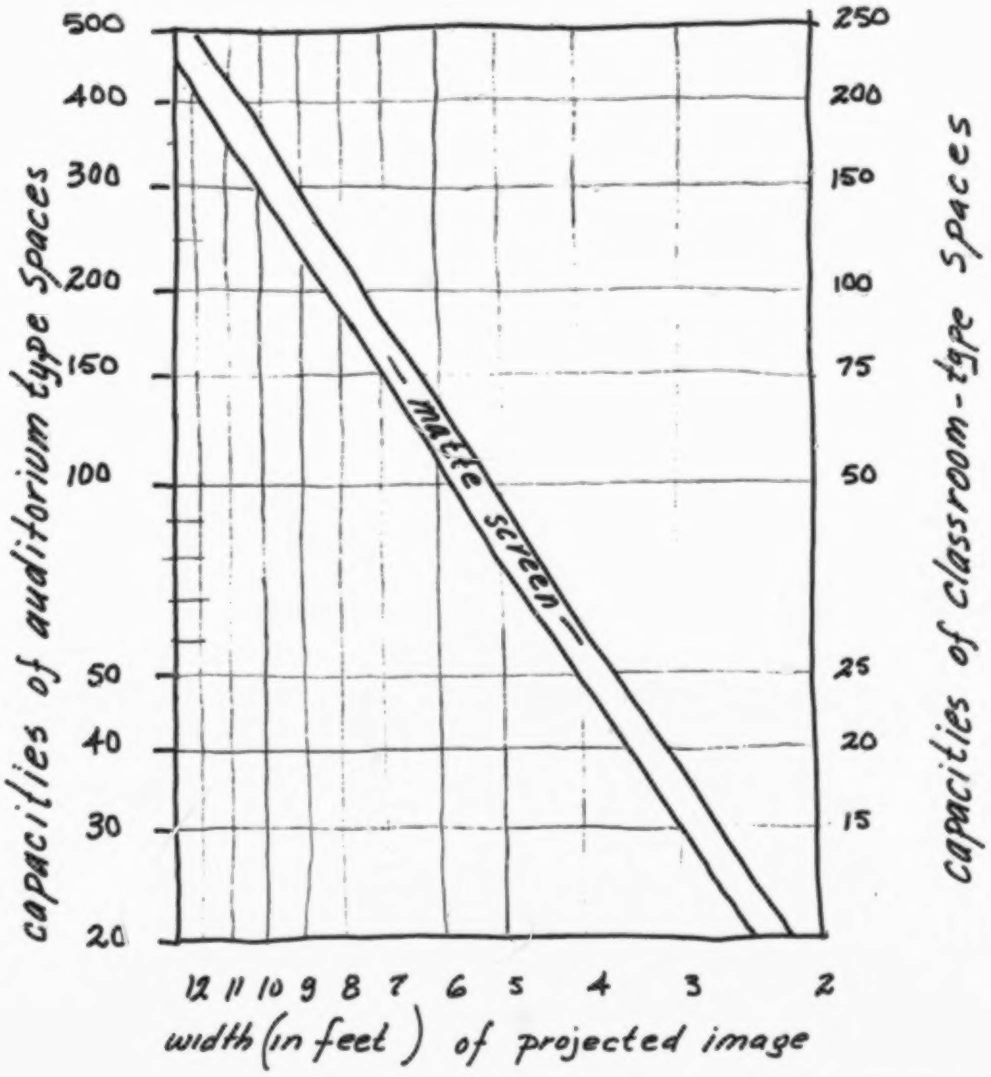
In general terms, for an image "W" feet wide projected on a matte screen:

1. The minimum distance equals 2 W.
2. The maximum distance may vary from 6 to 7 W.
3. The horizontal viewing angle may vary from 60° to 120°.
4. The maximum angle of elevation equals 15°.

The fold-out diagram illustrates five different approaches for determining a viewing area, and compares each approach on the basis of a single image, three images on one plane, and three images on three planes.

## Number of Viewers - Projected Images

Once the image size and viewing area are determined, the actual capacity is based on the function of the space. The following graph* shows in very broad terms a relationship between image size and capacity for the two general types of space indicated:



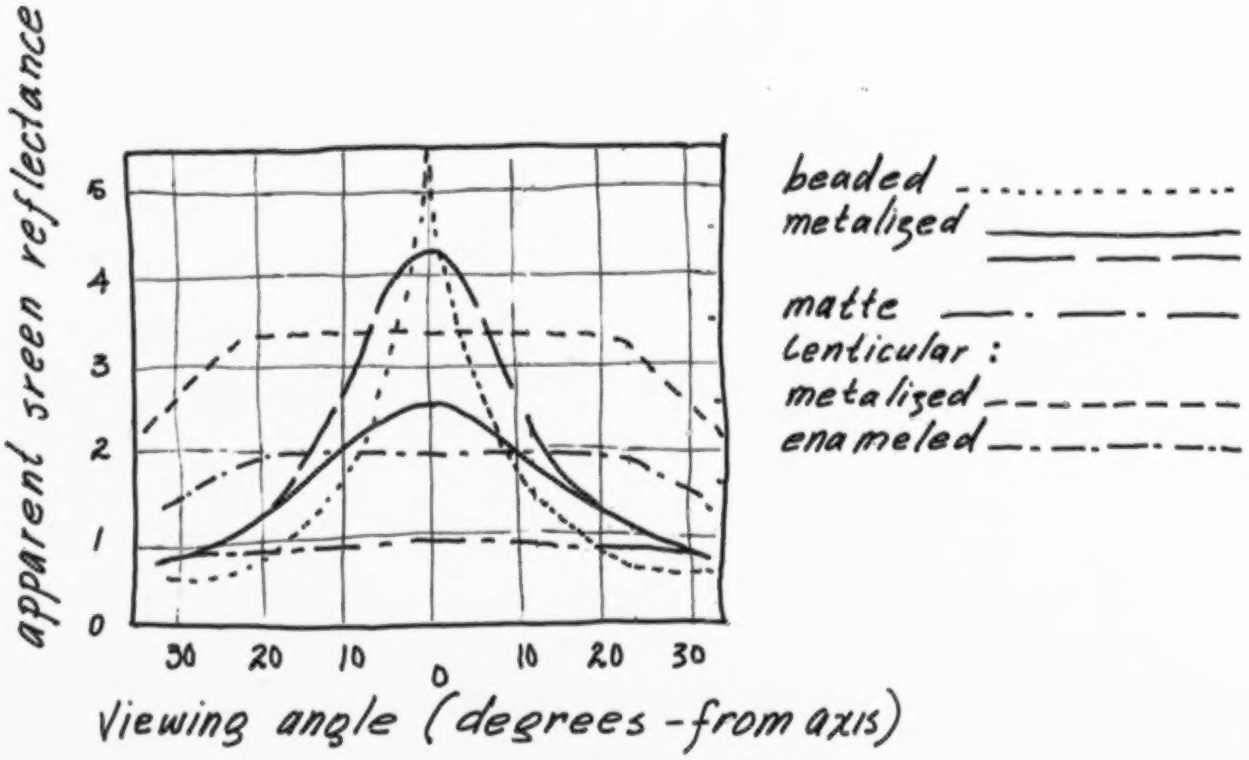
*Based on material published by the Eastman Kodak Co., Rochester, N. Y.

## Types of Screens

For front projection, four types of reflective screens are identified as follows:

1. Matte screens: non-glossy, non-directional surfaces which appear almost equally bright to all persons seated within recommended viewing ; includes fiberboard and plaster walls painted with non-gloss finish, as well as fabric screens.
2. Lenticular screens: surfaced with small uniformly shaped and spaced lens-elements controlling the direction of light reflectance so maximum brightness falls within certain specified viewing angles; may provide a uniformly bright picture for a viewing area comparable to a matte screen.
3. Beaded screens: white surfaces coated with fine glass beads; highly directional and reflect light towards its source; persons seated near projection beam see much brighter image than those seated towards the sides; somewhat limited use in large spaces due to narrow satisfactory viewing area.
4. Metallized screens: coated with paint incorporating a metallic pigment; may be highly directional or may approach the characteristics of matte surfaces, as such screens vary in reflectance characteristics; the more specular may have undesirable "hot spots" on the surface; limited classroom use due to possibility of reduced viewing areas.

A screen should be selected to meet the requirements of a particular space and projector-type. One of the determinants is the brightness pattern of the reflected image. The following diagram indicates the comparative brightness patterns for the four types of screen:



For normal projection with high lumen output projectors, and for the maximum number of viewers with equally satisfactory viewing conditions, the matte screens are probably most generally satisfactory. Where large image areas are required, the higher reflectance factor of the lenticular screens and their tendency to maintain good image contrast, even with ambient light, are advantages to be considered. If the projector has a low lumen output requiring greater screen reflectance, or if the space is narrow so that brightness fall-off to the sides isn't critical, then a beaded screen might be considered.

For rear projection, two types of translucent screens are identified:

1. Diffuse screens: usually of rigid or flexible plastic or plastic-coated materials that transmit light without controlling its direction; vary both in degree of dispersion and their reflectance of light from the viewing area; low dispersion screens product an image good for a narrow viewing area and may display "hot spots"; high dispersion screens have wider viewing area, but lower apparent screen brightness.

2. Lenticular screens: made up of lens elements which control the direction of light transmitted and result in carefully defined acceptable viewing areas.

For general use, the diffuse screens appear most satisfactory. In special cases with narrow viewing areas, special ambient light conditions or low lumen output projectors, the lenticular screens should be considered. Rear projection screens vary in their reflectance characteristics of ambient light in the viewing area; a low reflectance screen allows higher permissable viewing area lighting.

## Screen Brightness

One of the essential values to be determined in establishing criteria for room lighting is the screen brightness of the projected image as seen by the viewer (measured in foot-lamberts). This is a function of:

Projector light output (expressed in lumens)

Image area (measured in sq. ft.)

Reflectance value for the screen (for instance, .85 for a good matte screen)[1]

Amount of light falling on screen (footcandles)[2]

---

[1] Not a singular value for any screen, but varies with angle of incidence of light from projector, and viewing angle.

[2] Projector light output (lumen output) divided by image area in square feet equals amount of light falling on screen in footcandles.

Then:

$$S = R(L/A)$$

When:

S = screen brightness (foot-lamberts)
R = screen reflectance factor
L = light output of projector (lumens)
A = area of projected image (sq. ft.)

## Non-image Brightness

In addition to the light falling on the screen from the projector, stray light (ambient) from other sources of illumination often falls on the screens, decreasing the image contrast. Consequently, one of the primary considerations in designing the lighting systems for the learning spaces is the provision of illumination for note-taking and other tasks without permitting enough light to fall on the screen to reduce the brightness of the projected image below acceptable standards.

The amount of stray light is measured with a brightness meter in foot-lamberts. For the most accurate readings the projector is turned on, with the lens capped, along with the room illumination to be used with the particular projected device. The readings on the screen are then taken from the seating area.

Some authorities state that the ratios between image brightness (screen brightness from the projector) and non-image brightness (stray light falling on the screen) may vary, depending on how critical the projected material is. However, if this variation of ratios is strictly observed the lighting conditions may be misused, since the material in any one film or slide sequence may vary in itself from critical to non-critical. Therefore it is recommended that the lighting conditions for any one projection device be established for the most critical material, and used for all materials, critical or non-critical. In this way the best conditions for viewing all materials are assured. Non-image brightness is difficult to pre-determine, and can only be accurately measured by mocking-up spaces complete with lighting effects.

## Determining Projector Lumen Output Required

Knowing the non-image brightness on a screen, the required lumen output for a projector can be found which will maintain acceptable image brightnesses. The factors involved are:

Non-image brightness (measured in foot lamberts)

Screen reflectance factor

Acceptable ratio between image and non-image brightness

Projected image area (in square feet)

Then:

$$L = B/R \left(\frac{B'}{B^2}\right) A$$

When:

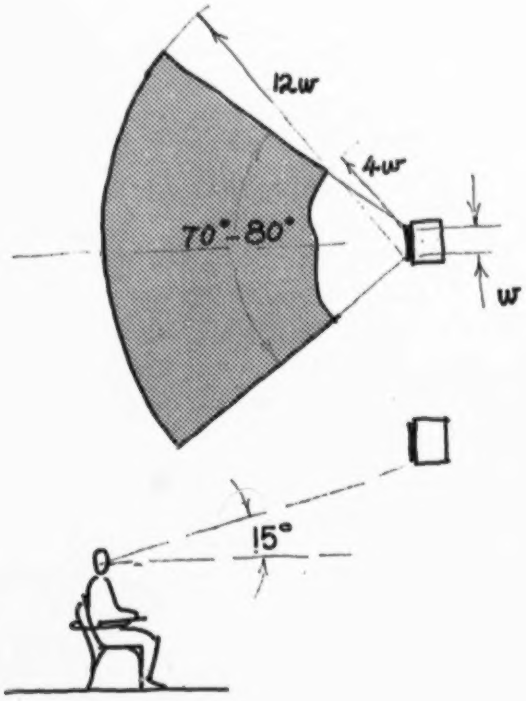
L = light output required by projector (lumens)
B = non-image brightness (foot-lamberts)
R = screen reflectance factor
$\frac{B'}{B^2}$ = acceptable image/non-image ratio
A = area of projected image (sq. ft.)

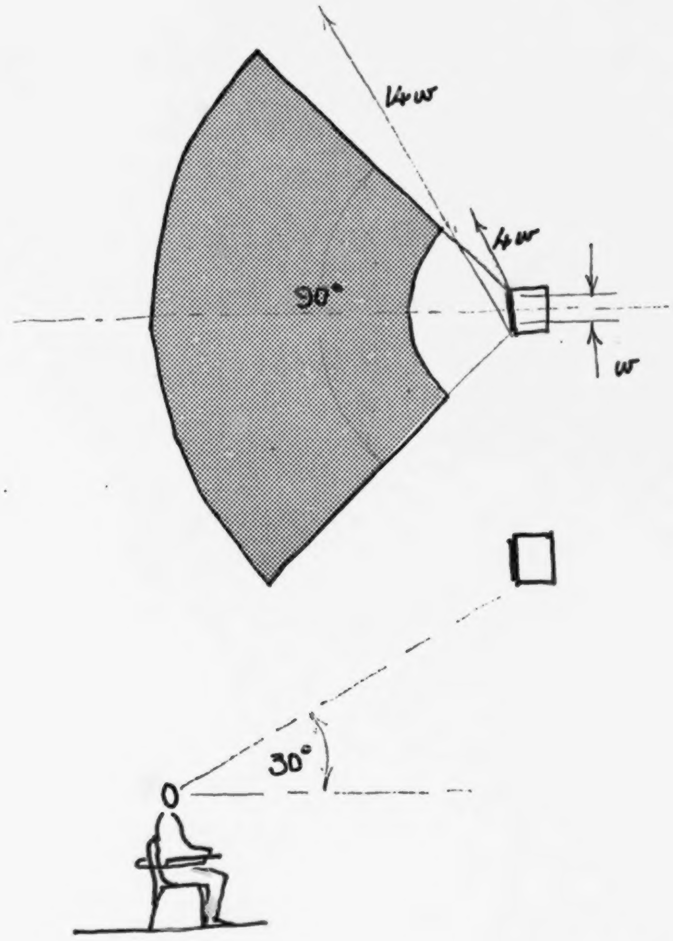
## TV Monitor Viewing

Because the definition of a TV monitor image is less than for, say, a film image, and the image brightness is greater, the viewing dimensions are somewhat different.

For optimum monitor viewing:

1. The minimum distance equals 4W
2. The maximum distance equals 12W
3. The horizontal viewing angle equals 70 - 80°
4. The maximum angle of of elevation equals 15° (to the bottom of the image.)





For less than optimum viewing:
The maximum distance may be increased to 14W, the horizontal angle to 90° and the maximum angle of elevation to 30°.

## Projected Television and Kinescope Viewing

It would seem logical that a television image projected on a screen would call for a viewing area equivalent to that for a slide or film projected image of the same size. Such is not the case. The definition of a television image is limited by the 525 lines of resolution, and the brightness of the image is usually less than that of a projected film image. This results in a relatively smaller TV image being considered more desirable. The ratio of image with (W) to maximum distance is, therefore, increased from the 6 to 7, mentioned previously, to 10 to 12.

Kinescopes projected on a screen follow the same ratio (10 to 12) as for projected television, since they are simply a film record of a televised presentation and thus have the same limitations.

## 4. Projection Methods

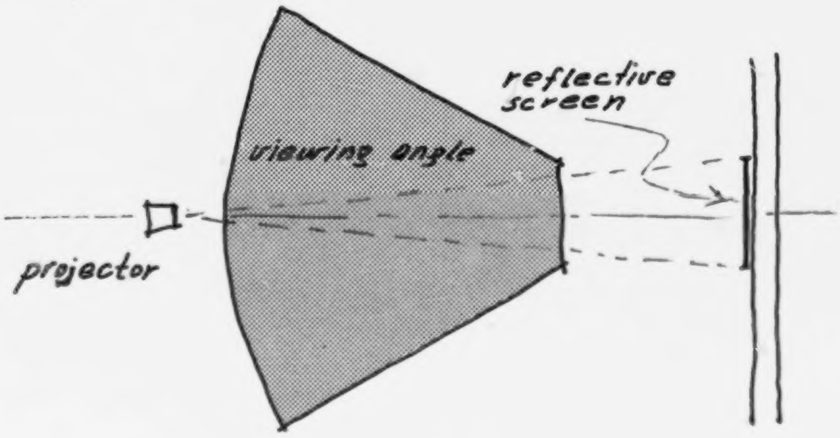
Since viewing projected images is one of the important functions of the learning spaces, the method of projecting the image is also of significance. This involves the relationships among projector, screen, students and instructor, and the demands these make of the room in terms of space, lighting, seating, accoustics and auxiliary equipment.

Essentially there are two methods of projection:
front screen
rear screen

Inherent in each are certain advantages and disadvantages that should be considered before making a choice.

### Front-screen projection

The projector is on the viewing side of the screen, and the image is displayed on a reflective screen surface.



The distance from the projector to the screen (the projection distance) is a function of the focal length of the lens and the desired image size and varies with the type of projector. As has been discussed earlier, proper image size is a function of the viewing area, and in turn, the screen type and viewing area are also directly related.

### Advantages of front screen projection:

1. Most available equipment is designed for front projection.

2. Projectors whose ratio of projection distance to image size is 6 to 1 or more can be located behind the seating area. Exceptions of course, are overhead and opaque projectors which are placed at the front of the viewing area, and are normally operated by the instructor.

3. Front projection conserves space, as the projection beam occupies space above the heads of the audience.

4. Such a veriety of reflective screen types are available (some of which are highly reflective and directional) that it is possible to select a screen with the viewing characteristics appropriate for a particular space.

Disadvantages:

1. Ambient light falling on the screen tends to reduce the brightness of the image. (A carefully designed lighting system with elimination or control of daylighting can overcome this problem)

2. The operating noise of the equipment within the room tends to distract student attention. (Accoustic treatment or isolation of the equipment may avoid this)

3. The seating must be carefully arranged to avoid students interfering with the projection beam or, in some cases, the equipment blocking a student's sight line.

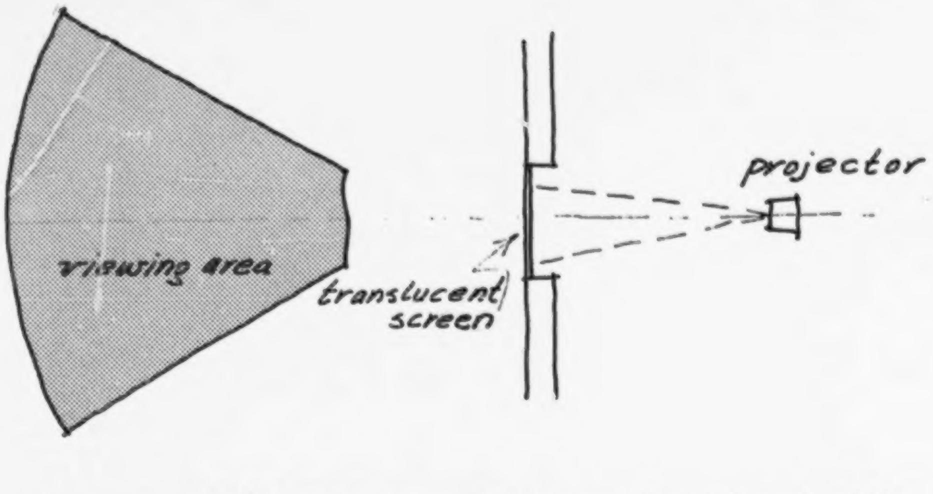
4. Unless remotely controlled, either the instructor or a technician must manipulate the equipment, which is an additional distraction. This is in addition to the inconvenience of having equipment, stands, cables, etc. within the space.

5. The heat given off by the equipment is difficult to control, unless a projection enclosure is used.

6. In rooms where TV monitors are hung from the ceiling, they may interfere with the projection beam.

Rear-screen projection

The projector is located behind the screen, away from viewers, and the image is displayed on a translucent screen.



Here also the projection distance is a function of the focal length of the projector lens and the desired image size. Obviously, to minimize the projection space, short focal length lenses with resultant shortened projection distances are desirable . However, this involves several drawbacks which are listed with "Disadvantages".

The image size and viewing area have the same relationships as for front projection. There are fewer screen types available for rear projection, and the viewing angle must be adjusted to the screen type selected.

Advantages of rear projection:

1. With some types of translucent screens, higher lighting levels are permissable in the viewing area.
2. With the projector separated from the viewing area by a rigid screen, the noise of operation and the distracting presence of an operator are removed.
3. Slides and films can be loaded in the projectors ready for subsequent presentation while a class is in session.
4. The viewing area is free from equipment and cables, and there is not the possibility of audience interference with the projection beam.
5. Heat given off by the projectors can be easily exhausted from the rear projection space.
6. An instructor can point out details on the image and large demonstration apparatus can be used without casting a shadow on the screen.

Disadvantages:

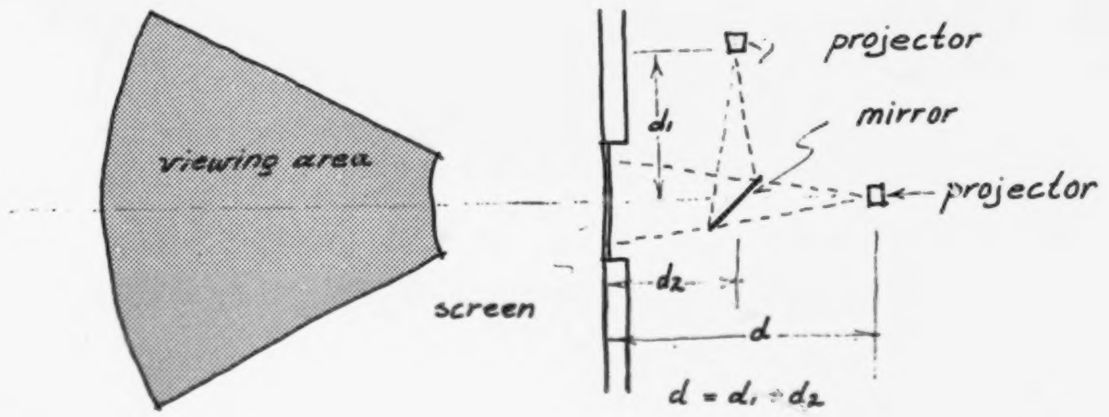
1. Rear projection requires that additional space be provided outside the seating area for equipment and projector beams.
2. Equipment with higher brightness may be required to provide images comparable to front projection. This is due to the light being transmitted through the screen instead of being reflected.
3. To conserve space, projectors with short focal length lenses, and hence short throw distances, are required. However, there are several disadvantages to short focal length lenses:
    a. They are more difficult to design and manufacture than longer focal length lenses and produce images that may be less sharp, have less contrast, and have curved edges.
    b. Projector illuminating systems are designed for longer focal lengths; when shorter focal lengths are used there is light loss.
    c. With short throw distances, the light toward the edges strikes the screen at a more acute angle resulting in an image that is unevenly bright.
4. The instructor cannot manipulate any of the equipment; either it must be remotely controlled or an operator must be stationed in the rear projection area.

5. Lighting in the rear projection space must be carefully controlled to avoid stray light on the screen which reduces the brightness of the image.

6. At the present time, there is a limited amount of equipment available designed specifically for rear projection.

## Indirect projection

The previous discussion of front and rear screen projection was based on images projected directly on the screen, with the axis of the projection lens perpendicular to the plane of the screen. Where space and equipment requirements do not permit direct projection, a mirror or system of mirrors can be used to "bend" the projection beam, the result being indirect projection. Indirect projection may be used for either front or rear projection, although it usually has greater application in connection with the latter. Relative to the screen, the projector may be located either above, below or to either side.

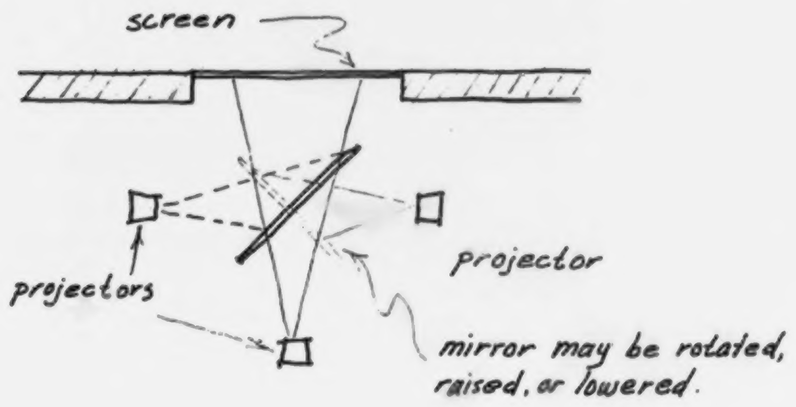


The diagram indicates that the projection beam for a given projector and image size is the same length whether directly or indirectly projected. In the latter case, the beam is simply bent with the mirror.

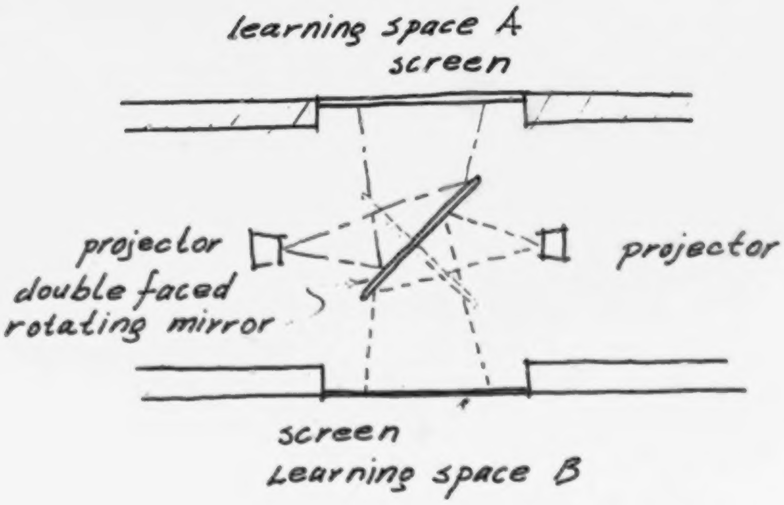
If a small mirror or prism is used near the lens, it must be precisely made and should be front-coated. If a larger mirror is used further away, these considerations are less important. In fact, with the mirror located at least 1/3 the projection distance away from the lens, any good quality standard rear surfaced mirror can be used.

In certain cases, to avoid a reversed image appearing on the screen, it is necessary to reverse materials as they are placed in the projector, or use an additional correcting mirror.

The following diagram illustrates multiplexing which consists of using more than one type of projector at different times on a single screen.


screen
projectors
projector
mirror may be rotated, raised, or lowered.

If two learning spaces occur back-to-back a multiplexing system can be used to rear project into both rooms simultaneously from a relatively narrow space, as shown below.


learning space A
screen
projector
double faced rotating mirror
projector
screen
Learning space B

If it is desired to have the mirror remain fixed, the projectors may be arranged on a "dumbwaiter" or sliding cart system. This permits the desired projector to be placed as needed in pre-established relationship to the mirror.

In a number of situations indirect projection can be used to overcome some of the disadvantages of direct projection, either front or rear. For instance, by using mirrors, the advantages of rear projection can be realized within less space behind the screen. Thus, more desirable long-focal length lenses, which require more throw distance, can be accommodated.

## 5. Lighting

As a general rule, too little attention is paid to the provision of proper lighting in buildings during the early stages of planning. The tendency is to postpone the lighting layout until all other design problems are solved, instead of considering illumination, along with structure, shape, color and texture, as one of the basic factors of integrated design. Too often, as a result, when the question of lighting is belatedly raised, it is found that some of the proper locations for lighting fixtures have been pre-empted by a structural beam or a ventilating duct, and the lighting scheme must be compromised accordingly.

Light should be considered as one of the "tools" of architectural design. To the design of interior spaces especially, it can contribute as much as the building materials themselves. Its functions are to provide:

| | |
|---|---|
| Visibility | (as influenced by the amount, color, distribution and control.) |
| Comfort | (elimination of glare and strain) |
| Composition | (architectural esthetics) |
| Atmosphere | (psychological effects) |

Since the use of daylighting is not recommended in the particular types of learning spaces discussed in this report, all of these functions must be performed by artificial illumination. The success with which these spaces fulfill their intended function will depend to a large degree on how they are lighted.

Among the most serious deficiencies of the typical conventional classroom for the use of projected materials is the quality of lighting and the inconvenience of controlling it. Darkening of the room necessitates lowering the window shades, or using special blinds, and turning off the lights. Then the room becomes too dark to take notes. Usually the light switch is located at some distance from the instructor, and typically there are no intermediate levels of lighting appropriate for the various projected media.

In the smaller rooms designed primarily for the viewing of projected images, while at the same time providing comfortable lighting for taking notes, there are two principal "task surfaces" , both of which should invite the students' attention:

- The projected image (or perhaps several simultaneous images)
- The tablet surface (the desk top or writing surface)

While these surfaces are in use, no other area or object in the room should be so lighted as to compete for attention. These two principal task surfaces should ideally be of about equal brightness, and, while they are the centers of interest, other surfaces within the room should be somewhat less bright, but should have a relative brightness ratio of not less than 1/10.

At times, though, certain other areas will require greater illumination, as attention is directed to them. These include:

The chalkboard

Wall charts and displays, and

The instructor himself

When the chalkboard or other supplementary charts or displays are used, they should have their own controllable illumination; when not in use they should blend inconspicuously with the general background. When the instructor becomes the center of interest, as during discussion periods, the general level of lighting should, in addition, be used to focus attention on him.

It becomes essential, therefore, to provide several types and levels of lighting in even the smaller rooms, with each level appropriate for certain functions. When using projected images, the brightness of the image is determined by the projection medium, the efficiency of the equipment, and the projection distance, and this brightness automatically becomes the reference point in determining other levels of illumination within the room. Different types of projection vary considerably in screen brightness. Thus, if a space is to provide adequately for the use of several different media, with its lighting keyed to their respective brightnesses, there must be several lighting levels readily available for the tablet task surface as well as for the general background illumination of the room. Further, as the number of differing media to be used in a room increases, the complexity of the lighting system and its controls may be expected to increase in proportion.

Control of the lighting should at all times be in the hands of the instructor, (or be pre-programmed) but the proper levels for each function should not be his choice. Instructors' preferences and idiosyncrasies vary and it is seldom possible to determine from the instructor's station what amount of light best serves his audience. Appropriate lighting levels should be predetermined and preset, so that the instructor's control extends only to the selection of sequence and duration.

Of necessity then, proper illumination in the learning spaces requires the use of several types of controlled lighting:

a) Lighting on the tablet task surface, for taking notes

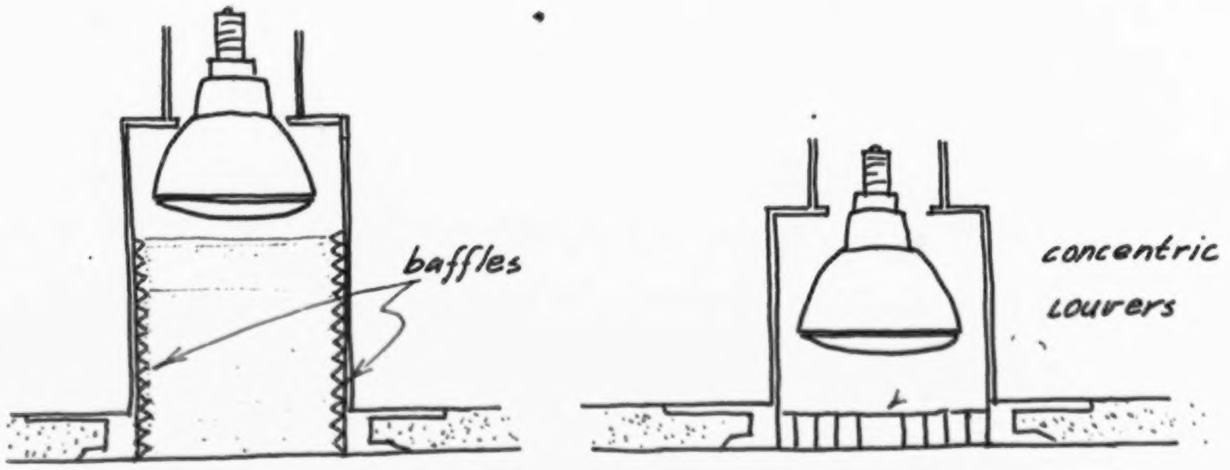
b) General background lighting of walls and ceiling

c) Local illumination of the instructor's station, chalkboards and display areas

It is of utmost importance, of course, that all these lighting effects be so designed that none of their light is allowed to strike directly on the projection screen and no bright spots are visible to any viewer as reflections on the TV monitor. These are the chief unique problems to be kept in mind. Technological improvements in TV receivers have reduced the problem of reflections, but not eliminated them. The serious effect of spill light in washing out projected images, especially those of low brightness, is an inescapable governing factor always to be reckoned with.

Brightness of the tablet surfaces (at table height above the floor) should, as indicated, be about the same as the average brightness of the image being viewed, so the frequent shifting of attention from one to the other does not require visual adjustment. There is little difficulty in taking notes under as little as 1 or 2 footcandles of illumination, but if this produces a brightness on the tablet much less than the average brightness of the image being viewed on the screen, it should be increased for comparative reasons.

Probably the most efficient way to provide the necessary tablet surface lighting is by means of suitable down lighting. Two appropriate types of this kind of lighting are shown in the following figure.



These lights are usually recessed flush in the ceiling, and should be aimed slightly forward of vertical in the general direction of viewing. Their maximum circle of spread, on the plane of the task surface, is usually considered to have a radius equal to their distance from this plane. These circles of illumination should of course overlap, so that no areas are without direct illumination. With a minimum room ceiling height of 10 feet, the approximate spacing of the light sources will be between 5 feet and 6 feet on centers. As the ceiling height increases, the spacing usually increases, and as the throw distance becomes greater, increased lamp wattage is needed to maintain similar levels of illumination.

In all cases such lighting should be capable of providing up to 35 footcandles on the tablet surface, and should be controllable to supply various lower lighting levels, down to a probably minimum of 2 to 5 footcandles. At the higher level, to be used only during general discussion periods, it is assumed that sufficient supplementary background lighting will be provided to give a total of at least 50 footcandles on the work surface.

Background lighting of wall and ceiling surfaces is essential under all situations, since these surfaces should never have less than 1/10 the brightness, nor any greater brightness, than the projected image. It may be that when images of low brightness are being viewed the spill from down lighting on the tablet surface will be sufficient to meet this condition, but in other situations some form of indirect lighting is needed. What form this may take depends on the size and shape of the room volume. In the smaller rooms, one appropriate method may be the use of shielded cove lighting at the ceiling periphery or near the top of the walls. In the larger rooms, spaced offsets in the planes of walls or ceilings (or both) provide a good location for lighting to sweep the areas between. An alternate solution in some cases may be the use of indirect V-trough lights suspended from the ceiling (at least 24 inches) provided sufficient light is spilled or reflected onto the walls, and no over-bright areas result on the ceiling itself.

Local lighting of the instructor's station or area in the smaller rooms will probably be provided by two or more concealed spots in the ceiling. Their location should of course not be directly overhead, but at sufficient angle to avoid grotesque shadows on the instructor's face, and, it is equally important that they provide as little distraction as possible to the instructor himself. A good location for these lights is on a line 55° above the horizontal from the instructor's face and on lines which in plan projection extend from the instructor's station to form a 90° angle.

Chalkboard and display lighting may also be provided by ceiling-mounted directional fixtures, or it may be supplied by inconspicuous trough lighting mounted on brackets projecting about 18 inches out from the top of the surface to be lighted. In either case it is highly important that no distracting "hot spots" of glare result either directly on the illuminated area or by reflection on adjacent surfaces. The use of bright metal trim around such areas is particularly distracting and objectionable, and should by all means be avoided.

In the larger rooms, the instructors' demonstrations at a table may be the principal center of attention, and in these cases the lighting of the demonstration area becomes another important consideration. Typically, a uniform intensity of about 100 footcandles should be provided on the table top areas from ceiling sources. Controlled beam spot-lights are usually recommended for the purpose. One of the most effective types is an ellipsoidal reflector-lens spotlight, equipped with beam-shaping shutters. The lighting problems here are closely related, of course, to those of stage lighting, and their planning usually deserves the attention and advice of a qualified lighting consultant.

Both incandescent and fluorescent lamps will probably be used to effect the overall lighting requirements in any of the learning spaces. The greater efficiency and operating economy of the fluorescent type recommend their use wherever appropriate, and being a slender, extended source available in a variety of efficient colors, the fluorescent lamp offers certain unique esthetic values also.

The incandescent lamp has the advantage of easy control, and can easily be dimmed to black-out. Down-lighting and spot-lighting will necessarily be provided by the use of incandescent lamps, but for general background lighting the use of fluorescent tubes may generally be preferred. The necessary control of brightness can be provided in those circuits by using rapid-start fluorescent lamps and thyraton-type dimmers.

## 6. Acoustics

Good conditions for hearing are just as important in the learning spaces as is their proper and adequate lighting, and just as with lighting, the acoustical properties should be "designed into" the spaces, rather than being added as an afterthought. Good acoustic properties can usually be provided in the average room at small if any additional cost when considered during the design process, but are certain to involve extra - and sometimes prohibitive - costs, if left for later "fixing up" after the room is found in use to be deficient.

Basically, architectural acoustics is concerned with two objectives:

1. the provision of a satisfactory acoustical environment, by raising barriers to unwanted sounds (noises), and

2. the provision of good hearing conditions, by controlling the direction, impact, and duration of sound waves.

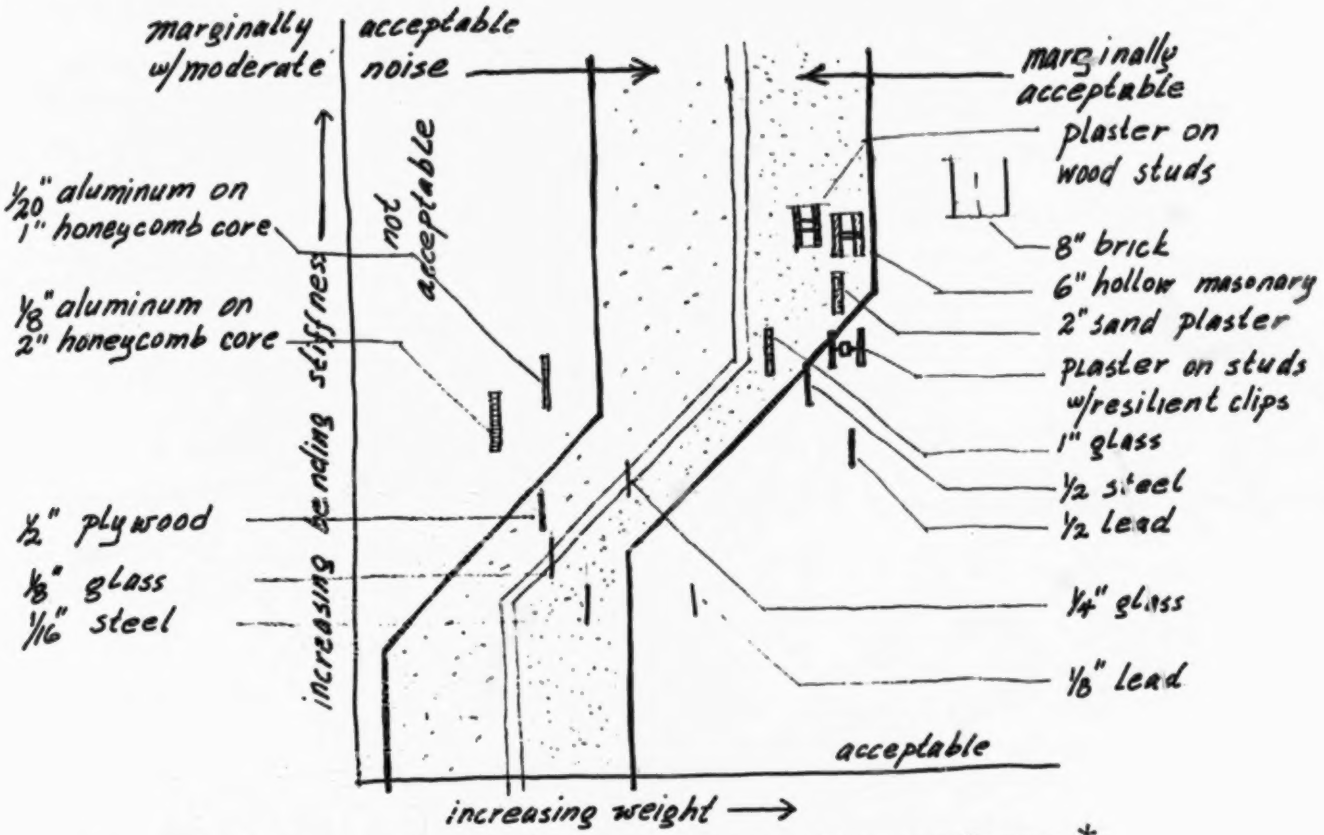
The first objective is concerned chiefly with the isolation of sound, - preventing its passage from one space to another by the transmission of sound waves through materials or open spaces; the second is concerned with the absorption and reflection of sound waves within the space itself. The accomplishment of both of these objectives depends upon the room shape, as well as the choice and judicious use of materials, and both are significant in the learning spaces. As might be expected the importance of acoustical considerations and design generally increases with the size of the room.

### Isolation

Sound isolation problems concern chiefly the construction of the walls, floors and ceilings between spaces, though they may also be caused by equipment within the room itself. It is in the construction of partitions in particular, that the lack of adequate isolation is generally most evident, and the current interest in lightweight flexible constructions has highlighted this fact.

Any openings in the construction of an intended sound barrier are leaks, which have the same significance as leaks in waterproofing. It is not impossible to achieve privacy with "flexible partitions", but it is usually expensive and always requires careful design and meticulous attention to details. Any true barrier to sound transmission must be airtight. All the sound energy that strikes a void, however small, goes right on through; a hole of only 1 square inch area in 100 square feet of wall having a 40 decibel transmission loss rating will "leak" as much sound as the rest of the wall.

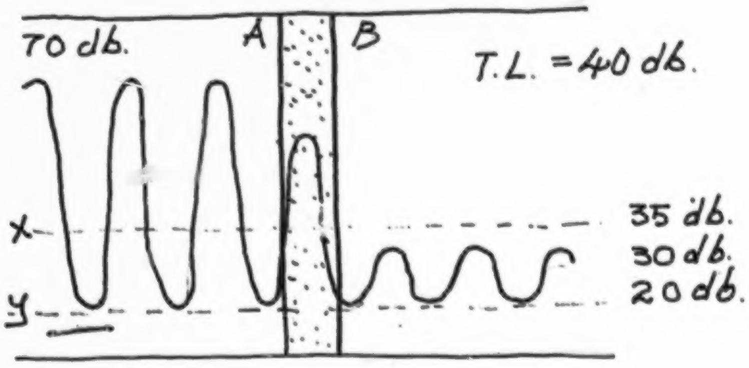
The sound-isolating properties of a barrier are determined largely by the mass and inertia of the barrier material, but weight alone is not enough. Stiffness, too, is an important factor. The best barriers are those which are heavy and "limp", or not stiff because their higher natural bending frequencies contribute to better overall performance values. Plywood sheet partitions, for instance, have been found to possess better transmission loss properties at most frequencies when nailed to spaced wood studs than when they are laminated to a core structure, because of the greater stiffness in the latter case. In the following illustration various materials considered for partition construction are graphically evaluated in respect to their weight and bending stiffness.


marginally w/moderate
acceptable noise
marginally acceptable
not acceptable
acceptable
increasing bending stiffness
increasing weight
1/20" aluminum on 1" honeycomb core
1/8" aluminum on 2" honeycomb core
1/2" plywood
1/8" glass
1/16" steel
plaster on wood studs
8" brick
6" hollow masonary
2" sand plaster
plaster on studs w/resilient clips
1" glass
1/2 steel
1/2 lead
1/4" glass
1/8" lead

Categories of Acceptability for Speech Privacy Between Spaces *

*Based on Material in
"Design for Hearing" by
Robert B. Newman
Progressive Architecture, May 1959

An important consideration in acoustical isolation is the significance of the background sound level, - the "acoustical perfume", as Mr. Newman* refers to it - in any situation. A high level of continuous background sound, such as may be experienced in city offices, serves to mask out many of the minor acoustical intrusions which, in more quiet surroundings, may be intolerable. The "perfume" effectively dominates many objectionable stray noises, - but in typical schoolroom situations the background noise level is rather low, at least during class periods, and the isolation value of the room enclosure consequently becomes more important. This is illustrated diagrammatically in the sketch at the right. Spaces A and B are separated by a partition having a transmission loss rating of 40 decibels. A sound intensity of 70 decibels originating in space "A" will consequently be reduced to 30 decibels in space "B". If the general background noise level is 35 decibels, as indicated by line x, the sound transmitted through the partition will generally go unnoticed, but if this


70 db.
A
B
T.L. = 40 db.
x
y
35 db.
30 db.
20 db.

*Robert B. Newman; Bolt, Baranek and Newman, Inc.

background is only 20 decibels (line y) the transmitted sound will probably be disturbing. As this example indicates, "the amount of acoustical privacy between spaces is equal to the sum of the background noise-level and the isolation provided by the construction".

Light-weight partition constructions having transmission loss ratings too low to serve as satisfactory sound barriers in themselves can, if space permits, be "doubled up" to advantage, provided they are spaced far enough apart. When placed in contact, the decibel losses are not additive; in fact the total transmission loss in this case may be only about 15% more than that of the single partition. With a foot of space between the two partitions, the total value of the double partition may increase to 150% of the single construction; but if three or four feet of space can be provided between the two, their total value will likely approach double the value of the single construction.

In addition to partition construction, there are other problems of isolation deserving special consideration in the learning spaces. The fact that generally these rooms will require mechanical ventilation emphasizes the necessity of careful attention to the arrangement of ducts and plenum spaces. Carelessness in the planning of such details can nullify all the values painstakingly detailed into the partitions, since slots and openings for air transmission serve admirably in transmitting sound from one room to another.

Mechanized projection equipment within the room may likely also be a source of objectionable noise, requiring some form of sound isolation. In the smaller rooms it may be sufficient to provide merely a small metal and glass enclosure with sound absorbing liner around the projectors, with access for loading and servicing the machines. If space and budget permit, a more substantial permanent partition isolating the projection equipment is to be preferred. With rear projection, the typical flexible screen used is necessarily an inadequate barrier against the transmission of sound from the projection room to the learning space. To minimize the disadvantages of this situation, interior surfaces of the projection room itself should be generously treated with absorptive material.

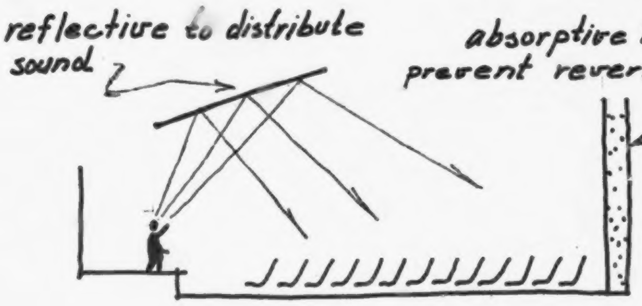
## Absorption

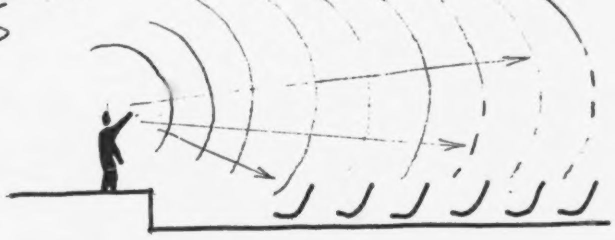
The quality of hearing as applied to sounds originating within the room itself, is governed by the size and shape of the room, the location and volume of the sound, and the reflection characteristics of the materials in the room. Reflection, in turn, depends on the ability of these materials to absorb sound energy. Hard, dense materials absorb very little sound, reflecting nearly all of the sound waves striking it, while soft, porous materials act oppositely, absorbing a large proportion and reflecting little.

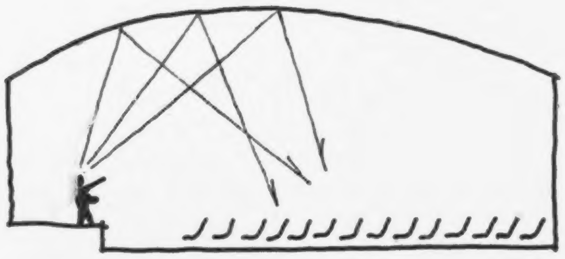
When large areas of porous materials such as carpet, upholstered furniture and special acoustical tiles and blankets are placed within a room, the reflected energy is greatly reduced, sound is largely absorbed and dies away quickly, and the "reverberation period" of the room is considered to be low. If, on the other hand, the surfaces lining the room are hard and therefore highly reflective, sound waves are bounced back and forth many times before they die out, and a long reverberation period results. This is the ringing and echoing condition commonly experienced in empty and unfurnished rooms.

It is a common misconception that good thermal insulating materials are also "sound insulating", in respect to transmission. This is not generally true. Sound absorbers, because they are porous and admit the moving molecules in sound waves, will also necessarily transmit sound. In fact it has been shown that good sound absorbers are nearly always good sound transmitters also.

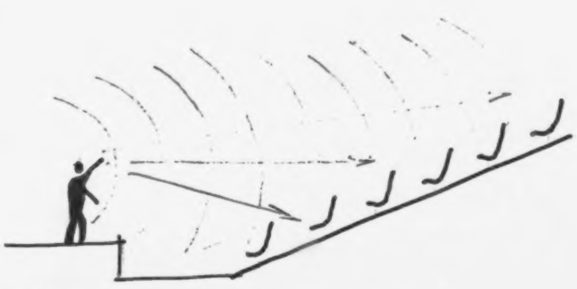
The objective, in designing for good hearing, is to so dispose the reflective and absorptive materials within the room that all occupants will receive as nearly as possible the same agreeable volume of sound, and no one will receive perceptibly delayed repetitions of the sound. This means that in general the surfaces relatively close to the sound source should be reflective, to amplify and disperse the original sound. Surfaces behind the audience and facing the sound source should be made absorptive, to minimize the rebound of sound energy which causes delayed repetition of the first hearing. As a rule, ceiling surfaces should be of hard reflective material and should be flat planes; curved surfaces should always be avoided because they focus, rather than disperse the sound. Non-parallel side wall planes converging in the direction of the sound source are preferred to parallel walls, as they improve the dispersion of sound and so tend to reduce the reverberation period.


reflective to distribute sound
absorptive to prevent reverberation





a curved surface may tend to focus sound rather than distribute it.



in a large space, a sloped floor will provide better hearing, as sounds will not be absorbed by persons in front.

Reflecting surfaces, whether in the walls or on the ceiling of the room, should be comparatively large, rather than small flat planes, with minimum widths of from 3 to 4 feet, and preferably 10 feet or more. Sound waves are reflected in simple "optical" fashion from a surface with the angle of reflection equal to the angle of incidence, when the surface dimension exceeds the wave length of the sound. At a frequency of 500 cycles per second the wave length is a little more than 2 feet, and at typical lower frequencies wave lengths are greater. If the surfaces encountered by the sound waves are small in comparison with the wave length (for example the face of a typical free-standing column) there will be no significant reflection of energy, but the wave simply goes around such an obstacle.

Acoustical treatment to improve hearing within the learning spaces is always important. In rooms designed to accommodate up to about 60 people, it will generally suffice to provide a peripheral area of absorptive material on all sides of the room except that occupied by the instructor. This may be either a border treatment, 3 or 4 feet in width, on the ceiling, or if ceiling height permits, a deep frieze treatment at the top of the walls. The central ceiling area is left hard and sound reflecting. As the usual absorptive material is comparatively soft and hence susceptible to damage, the ceiling location is frequently preferable unless the wall height is sufficient to install the material above head level.

The larger spaces, as a rule, require more careful attention, both as to shape and disposition of surfacing materials, if optimum hearing conditions are to result. Otherwise as room dimensions increase, reverberation, distribution, and volume may become problems. It is in these larger rooms that the conformation and reflective quality of the ceiling are especially important. Provision , in effect, of an inclined "sounding board" surface over the instructor's area, to reinforce and disperse the normal speaking voice is a basic essential, and in most cases this can be provided by the conformation of the ceiling itself. The remainder of the ceiling treated as a series of large flat reflective planes offset in sawtooth fashion by substantial absorptive breaks, side walls splayed, and a rear wall also of highly absorptive material, are characteristic of the acoustically ideal concept of these larger spaces. Other considerations may of course alter some of these features, but this general concept should be the goal.

## Sound Systems

For conventional "face-to-face" teaching and lecture demonstrations no artificial amplification system should be necessary in any room seating 600 persons or less, if the room is designed to provide reasonably good acoustical properties. As much of the teaching in these rooms will not be of the conventional type, though, but instead will make use of electronically produced sounds, both live and recorded, the distribution of "piped" sound becomes an essential part of the design problem. With a built-in sound system being required in any case for such uses, it may be desirable, in the larger rooms, to so design it that it can be used also for amplification and better distribution of live sounds originating within the room. In all cases, whether so used or not, there should be only one sound system in any learning space, designed to accommodate interchangeably all the various needs, - sound tracks on film, radio, audio tapes, television audio, intra-room announcements and, if desired, sounds picked up by room microphones.

There are basically two types of sound distribution systems:

1. Central, high level systems with a single loudspeaker located in the center front of the ceiling, or on the center upper part of the front wall - (i.e. the loudspeaker is located in the general vicinity of the speaker to provide realism)

2. Distributed, low level systems with the loudspeakers located in the ceiling, facing down, and covering only a localized area. The loudspeakers should never be located on the side walls of a room.

For the learning spaces, the central high level systems appear to be the most feasible.

## 7. Mechanical Equipment

At first glance it might appear that heating and air-conditioning of the learning spaces would involve only routing problems. It is true that no unique devices are necessary and that standard design procedures, using readily available data, may be followed. However, certain conditions arising from the nature and use of these spaces require specific consideration and special care in their design. These conditions are:

1. That the spaces under consideration will have no windows,
2. That the number of occupants per unit volume will be relatively large,
3. That a good deal of electrical heat-producing apparatus will be used, and
4. That the normal visual environment for projection may be conducive to drowsiness, an effect which may be reduced by well-designed air-conditioning.

The use of windowless spaces, as dictated by considerations other than those of heating and air-conditioning, places special emphasis on the need for temperature control. Without provision for natural ventilation through windows, it is essential that the temperature control system involve air handling. A fan and duct-work system must be provided to introduce proper quantities of fresh air. The amount of fresh air required will depend upon the efficiency of the air cleaning system, but should be not less than 10 cubic feet per person per minute, with minimum cleaning provided by dry filters. In unusual cases where smoking may be permitted, as in a seminar room, it would be advisable to consider more effective devices for controlling odor and removing dust particles. These might be activated carbon filters or a liquid absorption system.

Conduction of heat and infiltration of air at windows normally constitute a major portion of the heat transfer into and out of a space. Many of the types of spaces considered in this report will be on the interior of the building and will have little exposure to outside temperatures. Even where the room wall surfaces are exposed to outside temperatures, normal insulating values will result in relatively low heat transfer.

Sources of heat gain within the spaces will be substantial, and except in extremely cold weather, may exceed the transmission losses to the outside. A person at rest may be expected to contribute about 300 BTU* per hour to the room. To this must be added the heat given off by the lighting and electrical apparatus at the rate of 3.413 BTU per hour per watt. Therefore, the dominant temperature control problem will probably be that of cooling, even in the colder climates.

Because good hearing conditions are fundamental to the use of these spaces, it is important that great care be taken in the design of the fan and duct-work systems. In selecting equipment, the rated noise levels should be examined carefully, and the designs should be such that the noise introduced into the space will be minimum. To accomplish this, it is unlikely that it will be feasible to have the air-handling equipment located in the space itself.

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*British Thermal Unit - a measure of heat output.

Designers should provide a space for this equipment isolated acoustically from the learning spaces, with sufficient length of connecting duct-work so that the fan and other equipment noise will be reduced to a satisfactory level. With a duct lined with sound-absorption material, it would be advisable that the length of duct be not less than about ten feet. There is some advantage in having turns and other irregularities in the duct-work to aid in reducing noise transmission. Should these requirements be unusually difficult to satisfy, the designer may resort to more complicated methods of acoustical attenuation.

Too frequently in the design of classrooms, insufficient attention is given to providing climatic conditions conducive to learning. The problem is not simply that of producing "comfort", but of creating an atmosphere in which the students will be alert and attentive. In spaces devoted principally to the use of audio-visual aids, this problem may be quite serious. With low level illumination, lack of variety provided by changing sunlight and a view from windows, and with projected material which is instructional rather than entertaining, even the best students may find it difficult to stay alert and receptive.

Proper climate control can do much to minimize these effects. Temperature must be held within close limits and related to outside temperatures. In hot weather an over-cooled room will require a physical adjustment which will be detrimental; in cold weather an over-heated room will be dulling to the senses.

Air movement is an important factor also in providing a proper environment. Without producing a draft, there should be enough circulation over the surface of the body to carry away the layer of hot, moist air which tends to form at the surface of the skin. Humidity must be controlled, but is not as significant as proper air motion and temperature. The range should be from about 30 to 55 percent relative humidity. The designer will recognize that the central plant must remove moisture given off by the occupants by evaporation.

Two additional considerations are of importance. First, the amount of heat generated within the spaces will vary widely, ranging from zero when they are not in use to maximum when they are fully occupied and the projection equipment is in operation. Second, there will be no possibility of individual adjustment of the conditions by opening or closing windows. Thus, the fluctuating requirements of the air-conditioning system will be such that each space will probably require individual control. Ventilation will be needed at all times, and the system must be quickly adaptable to differences in the pattern of thermal loads in the rooms.

There are several methods of meeting these fluctuating requirements. The most flexible would be a double-duct system in which air is carried at different temperatures in two parallel ducts. It would be an advantage to have closed loops formed by the ducts so that there are two paths for air to any point. In this way a change in the demand can be handled without causing excessive disturbance in the friction drop of the duct-work. Mixing boxes connecting with the two ducts would draw air from each in proportion to the air temperature required for introduction into the room, and the temperature would be determined by thermostats operating controls at the mixing box.

## Learning Spaces

It will propably be found impractical to introduce the air into the room anywhere except at or near the ceiling. Since a large portion of the floor space is to be occupied by seating, any outlet located at a low level would likely produce an uncomfortable draft, particularly when cool air is being supplied. Proper air distribution can best be accomplished by the use of ceiling diffusers located to cover a specific floor space or area. With high side-wall inlets air would necessarily have to be introduced at a relatively high velocity in order to convey it properly throughout the room. In rooms with low ceilings this velocity might produce drafts and cause undesirable noise at the supply grills.

Return-air grills should be located so that the air flow is reasonably uniform over the occupied area. They should preferably be at a low level, either on the side walls or under the seats. If a sufficient number of return grills are used, and they are of adequate area, there will be little difficulty with drafts.

In the location and routing of the duct-work care must be taken to avoid cross-talk between rooms. Sound from adjacent classrooms, particularly if it is amplified, carries quite readily and distinctly through duct-work. There should be an adequate length of duct between the outlets in different rooms to avoid annoying sound transmission. If a double-duct, mixing-box system is used, individual runs from the box should be lined with sound absorbing material. This is an important precaution, and should be given most careful attention in designing the duct layout.

Power requirements in many of the learning spaces will be sizeable, and an adequate supply should be provided. In most cases there will be separate distribution centers (panel boards) for lighting and power. As the general trend is toward higher powered projection equipment, provision should be made in the initial installation for a probable later increase in power requirements. All services and equipment should be easily accessible for repair.

## 8. Equipment and fixtures

An essential design requirement of the learning spaces is the accommodation of the various equipment types required to enable their performing particular functions or systems of functions. Essentially these types consist of the monitors, projection apparatus, screens and additional equipment necessary for producing images and sounds; and the seats, desks and room furniture.

Within the scope of this report it is impossible to present data on all the various types and makes of equipment which can produce images and sounds. It is essential, however, that the designer consider carefully the characteristics of the equipment to be utilized during the very early stages of design.

In a more general way, there are several topics that should be discussed here which will have bearing on the broader problems of design.

Stand-by equipment. When televised instruction is being broadcast live to a number of receiving points, the loss of instruction caused by a break-down in the receiver may be critical. For this reason, the use of stand-by equipment should be considered. If, in spaces where a number of monitors are used, one becomes inoperative its viewers can simply watch other receivers. However, in the smaller spaces, such as seminar and small-group rooms, designed as "one monitor" spaces, the break-down becomes significant and methods for overcoming the interruption must be considered.

Monitors, pre-mounted on moveable carts, can be stored in a readily accessible central area and rolled into the classroom when needed. Some persons have indicated that no room should be designed with only one monitor; there should be at least two so in case of breakdown the second can be switched on. Also, if a room is designed to receive live televised instruction, a smaller portable monitor can be housed in a storage space in the room and connected when needed.

Finally, if the televised instruction is kinescoped or put on video tape, students can review the material missed during the break-down. Provision for stand-by equipment may be necessary with media other than television.

Preventive maintenance. A thorough and continuous preventive maintenance program will greatly reduce the need for stand-by equipment. An institution whose instructional program depends to any degree on technical aids will find such a program a very necessary service resulting in long-range savings of time and instructional talent, as well as dollars. Such a program can be handled by contract with the suppliers of the equipment, if the institution is not setup with an internal maintenance organization.

Organization of display surfaces. With the use of multi-aids in the classroom it is well to consider the arrangement and organization of the various screen surfaces, chalkboards, tack-boards, monitors and other display surfaces into an "instructional surface". This approach simplifies the handling of lighting and wiring and may permit pre-fabrication of the entire display with an integrated sound system. This latter approach is indicated by the design of the "Image- Sound Unit" developed as an integral part of Design Study L

Projection center. For a learning space or group of spaces, it also becomes beneficial to organize the various pieces of projection equipment into a single projection center or core. This simplifies operation and readying of equipment, lighting, ventilation, maintenance, as well as the requirements for remote-controlling of the equipment by the professor. Again the Design Studies illustrate several approaches to the Projection Center.

Seating types. Of utmost importance in the learning spaces is the selection of the type of student seating. The learning spaces considered in this study are designed so that the seating area is in a specific relationship to the display surfaces, and often the floor is stepped or sloped. For these reasons, fixed seating is a logical choice, and particularly the pedestal chair for ease of maintenance. In the seminar-arranged rooms, the swive-pedestal chairs will provide the necessary movement of the chair to enable the student to face other students in the class.

In all spaces the provision of adequate writing surfaces is essential. Many of the tablet arm chairs currently available are not adequate from this standpoint; this is particularly true of the auditorium-type seating with the fold down tablet surface. For this reason, a continuous writing surface with fixed seats, probably folding, may be used in many of the large spaces.

Modular-cart concept. Several of the large spaces are designed to support lecture-demonstrations where large-scale models and apparatus are used with the aids to demonstrate various experiments and processes. In similar conventional situations a large lecture table is provided, often up to 4 feet wide and 20 to 30 feet long, on which the various apparatus and equipment are set. This is not a particularly workable solution as, regardless of the type and extent of equipment involved, the lecturer is always limited by the inflexible dimensions of the table.

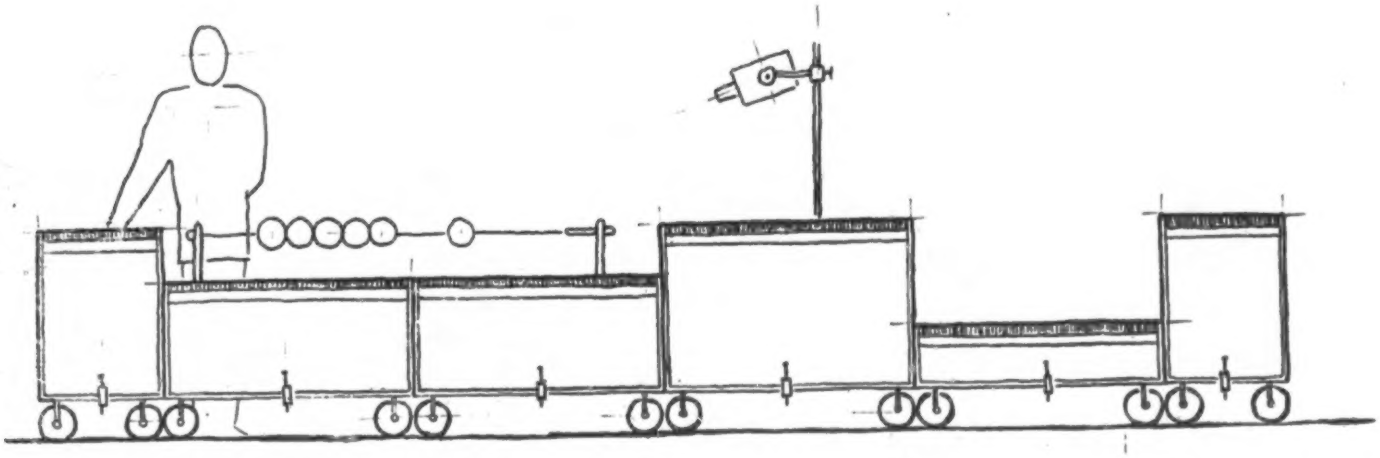
By "unitizing" the table, more flexibility of arrangement can be achieved -- as few or as many of the units can be used as needed -- and apparatus and equipment frequently used can be permanently mounted, each on its individual stand. Toward this end of simplifying the utilization of lecture-demonstration equipment, the "modular cart" concept was developed, and applications of this concept are shown in several of the larger-capacity schemes.

Turn-table and slide-on stages. A large-capacity space must necessarily be designed to permit a high utilization rate in order to justify its initial construction. This concern is often incompatible with lecture-demonstrations which, by requiring set-up and take-down time, ties up the space. To alleviate this situation one approach has been the design of turn-table or slide-on stages, whereby the demonstration is set up off-stage while the room is in use. The stage is then turned, or slid on during the break between classes to put it in position for the next class. This also permits demonstrations to be readied several days in advance.

For a single large space, the turn-table approach seems to permit greater flexibility of use and operation than the slide-on and does not require the extra space inherent in the slide-on. However, if multiple audience spaces are required, the slide-on stage may be the better approach.

# MODULAR CARTS - developed for lecture-demonstrations

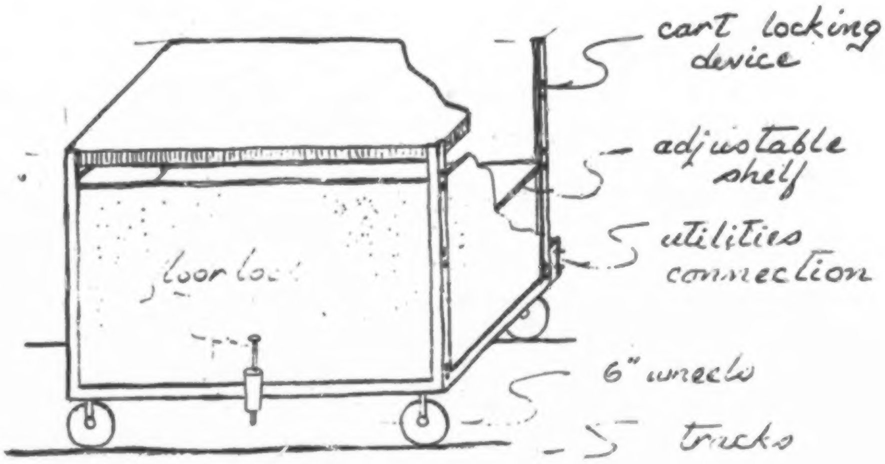
Concept: By unitizing the conventional demonstration table, greater flexibility in equipment and arrangement is permitted. Apparatus, TV cameras and controls, utilities, and projection devices can be installed on individual carts which can then be easily moved on and off the stage and readied for a lecture in whatever combination is required. After being moved on the stage, the carts are locked in place by "floor locks".



*elevation of typical carts in place on stage*

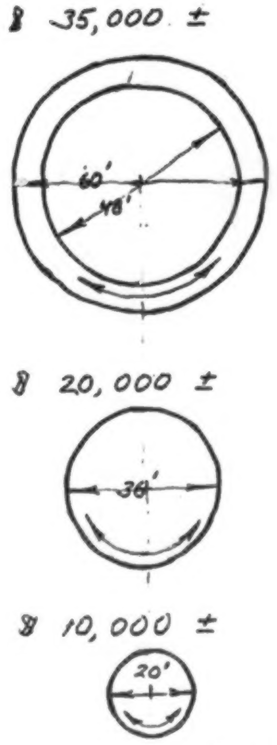
The carts vary in height and length but are based on 2 foot increments. Carts may be developed for functions such as:

A. Service (sink, exhaust hood, etc.)
B. Lectern
C. Overhead projector
D. Shadow projector
E. Television camera
F. Television camera with microscope
G. Physics, chemistry, and other science demonstration apparatus
H. Special equipment

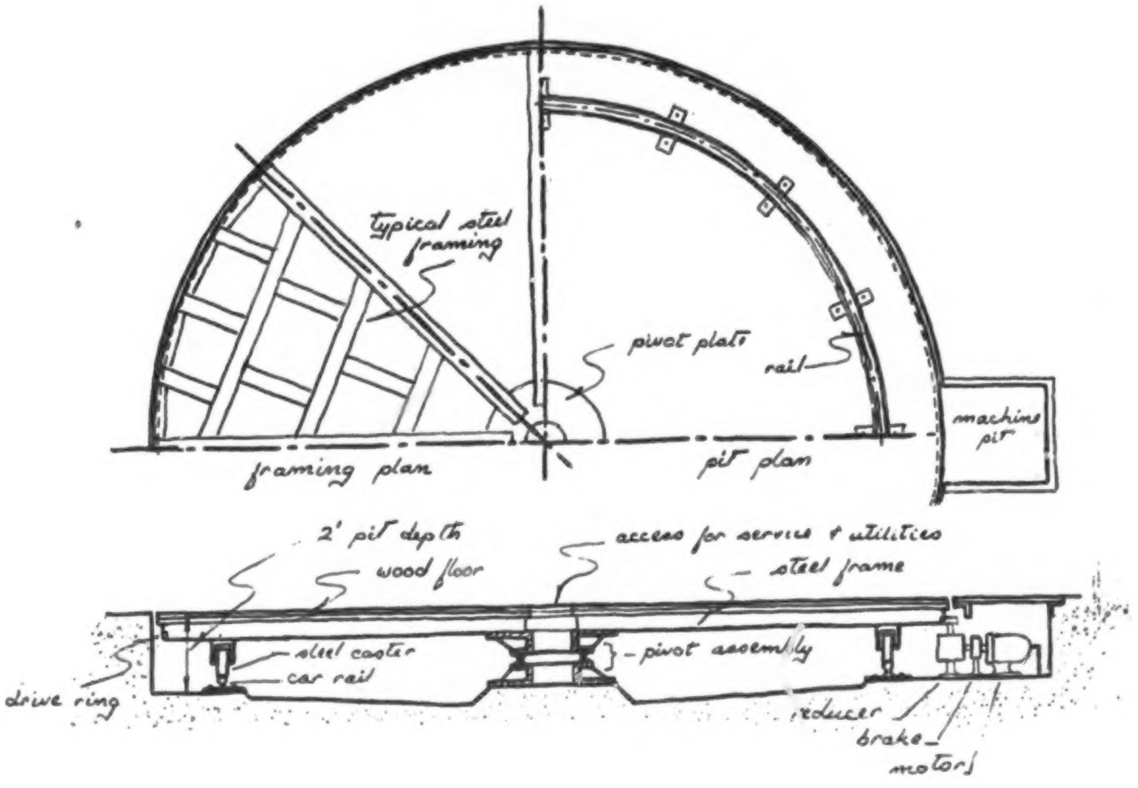


*isometric cutaway of typical cart*

# TURN TABLE STAGES - basic data *


$ 35,000 ±
60'
48'
$ 20,000 ±
30'
$ 10,000 ±
20'

comparative costs


typical steel framing
pivot plate
rail
machine pit
framing plan
pit plan
2' pit depth
wood floor
access for service & utilities
steel frame
steel caster
car rail
pivot assembly
drive ring
reducer
brake
motors

plan & section

(- based on perimeter track operation -)

Methods of operation:
  Central pivot support (for small stages only)
  Perimeter track with rollers.
    a) Spur gear driven } ½-5 horsepower motor
    b) Chain gear driven } (3 phase current - 220-440 volts)

Rate of rotation:
  ½ to 2 revolutions per minute

Clearances:
  ¼"-½" between stage and surrounding floor.

Noise control:
  Underside of turntable sprayed with acoustical material.
  Pneumatic gaskets used at side walls and ceiling.

Methods of bringing utilities onto stage:
  Central core with flexible connections for water, drainage, etc. (The 2-part stage rotates 180°, the 3-part 240°)
  Modular carts designed for water, drainage, etc.

*based in part on material supplied by Joseph Vasconcellos, Inc., West Babylon, L. I., N. Y.

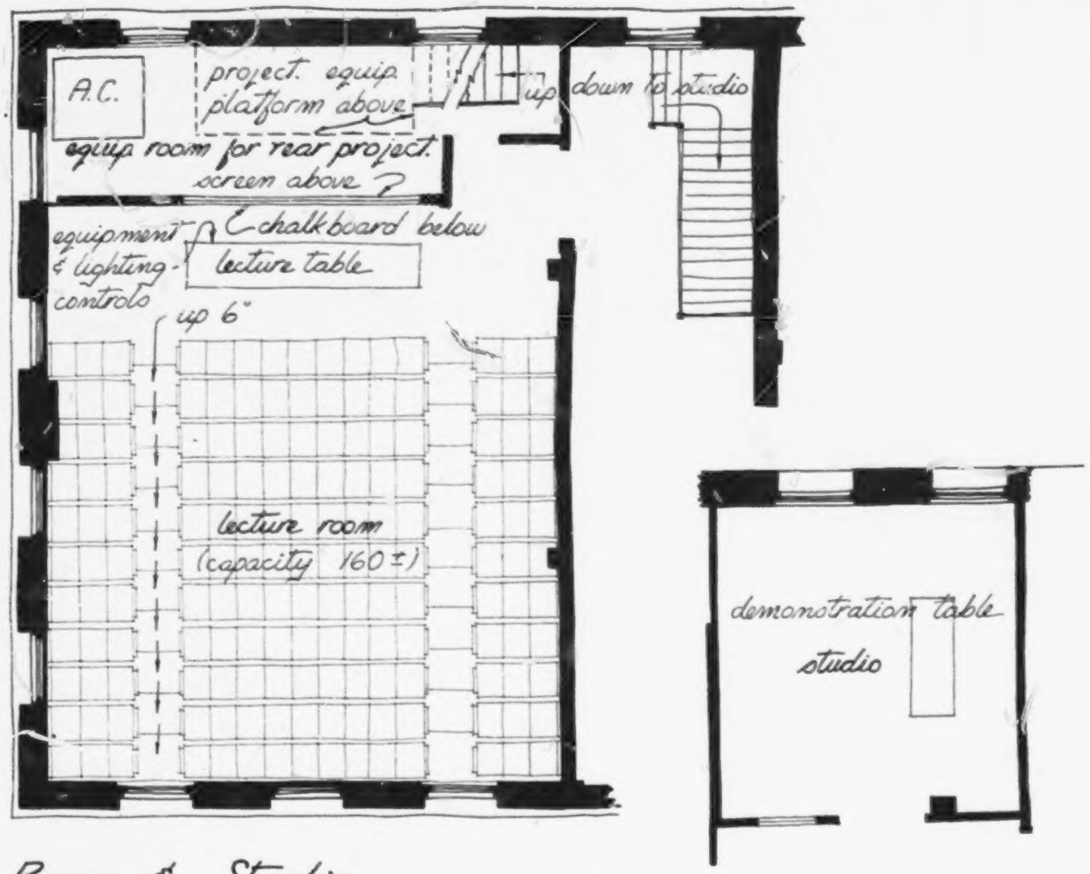
The design studies indicate both two-and three-part turn-tables with either front or rear projection. With rear projection, the turn-table must rotate beneath the projection area, so that apparatus is limited in height to about eight feet.

By utilizing modular carts with the slide-on or turn-table stages, a high degree of flexibility of time and use can be achieved, resulting in a high utilization rate of the facility.

## 9. Examples of Existing Facilities

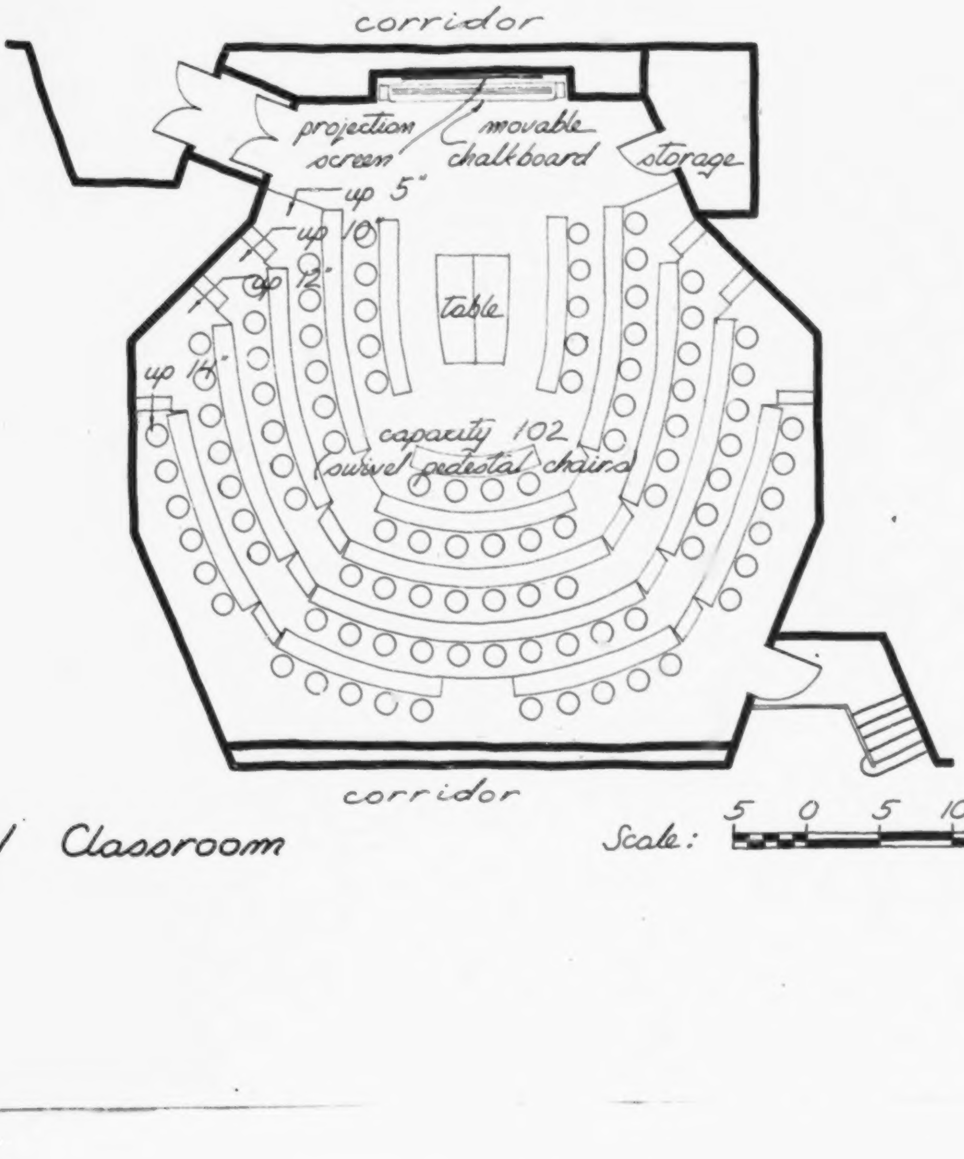
The following drawings and text describe some of the existing facilities reviewed during the course of the study. The particular examples were not selected because they represent necessarily outstanding facilities, although many of them are, but because they incorporate certain features or exhibit particular planning consideration discussed in this report. Some of the features are the use of slide-on and rotating stages, the inclusion of areas for rear-screen projection equipment, the location of demonstration and projection stands, and the provision of multiple-image display surfaces. The planning considerations include relationships of TV studios, preparation and storage areas; the organization of the audience area for lecture as opposed to seminar-type spaces; and the arrangement of several rooms of one type into an actual plan.

Without doubt, other facilities across the country contain equally significant and pertinent features and planning considerations. As many of them as possible should be reviewed prior to designing facilities with similar characteristics.


A.C.
project. equip. platform above
up
down to studio
equip room for rear project. screen above ?
equipment & lighting-controls
℄ chalkboard below
lecture table
up 6"
lecture room (capacity 160±)
demonstration table
studio

Lecture Room & Studio

Scale: below


corridor
projection screen
℄ movable chalkboard
storage
up 5"
up 10"
up 12"
up 14"
table
capacity 102 (swivel pedestal chairs)
corridor

Typical Classroom

Scale: 5 0 5 10 20

Room 101 - Troy Building
Rensselaer Polytechnic Institute

This is a remodelled lecture room designed as a demonstration classroom in which faculty members can utilize rear-projected aids and closed-circuit television in various course presentations. It is used primarily for receiving, via closed-circuit, the Strength of Materials Laboratory which originates from the studio-laboratory in the basement of the same building. The rear-projected aids include 3 x 4 slides, 2 x 2 slides, 16 mm motion pictures, and projected television, all of which are remotely controlled from the lecture table. The same panel also has controls for lighting (permitting a variety of levels and effects) and the inter-com system with the studio. A single microphone in the lecture room permits students to ask questions of the studio instructor.

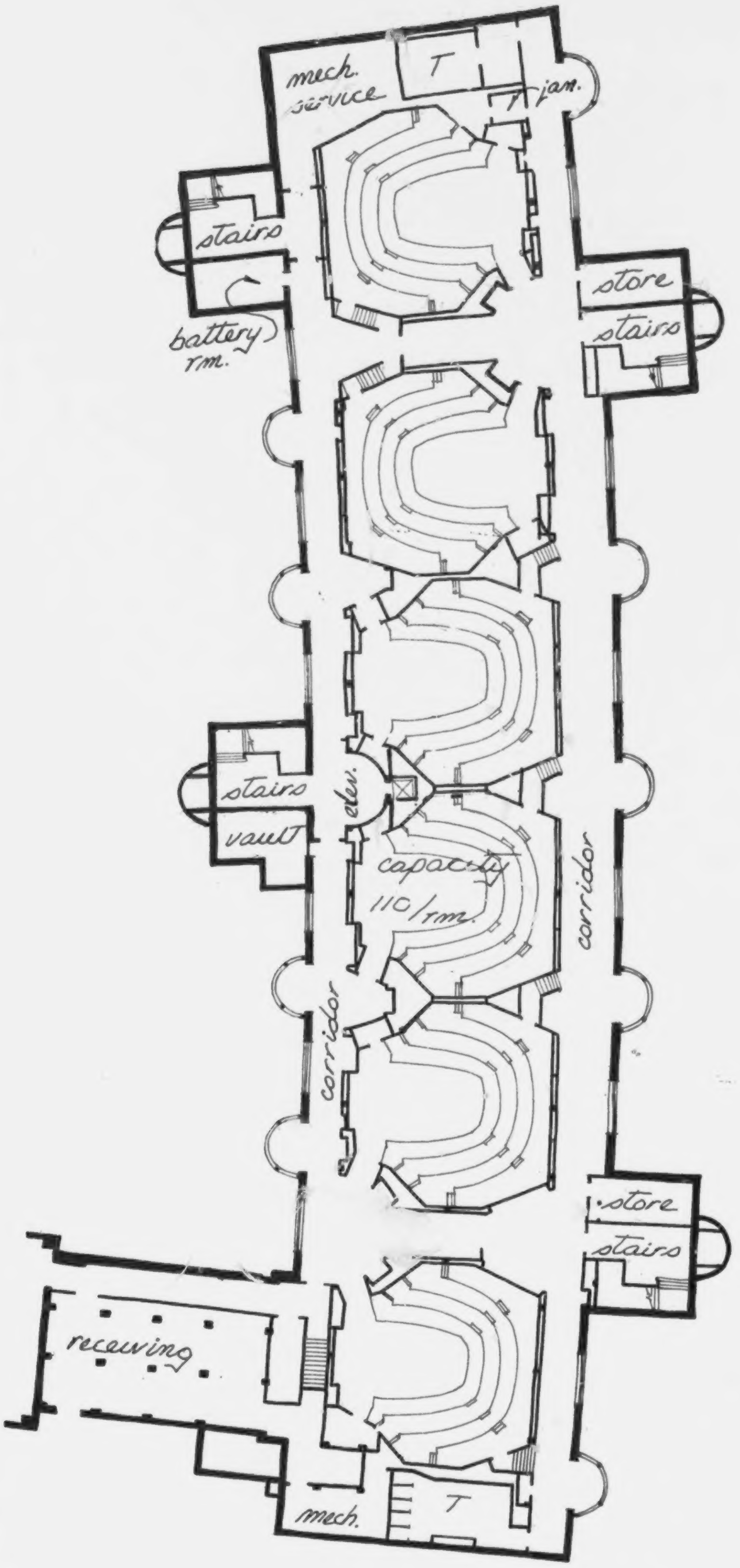
Architects for the remodelling:
W. Parker Dodge Associates
Architects and Engineers
Rensselaer, New York

Typical Classroom
Aldrich Hall, Harvard Business School
Harvard University

This illustrates one of 17 similar classrooms that make up Aldrich Hall. The classrooms were designed specifically for the case-method type of instruction which demands considerable discussion and interaction among the students as well as between professor and student. This is accomplished by a semi-circular arrangement of continuous writing surfaces with swivel pedestal chairs. The concentric rows are stepped to permit the best sightlines and viewing for everyone in the space. A screen is provided at the front of the room for materials projected either from the central space or from the opposite side of the room.

Architects: Perry, Shaw and Hepburn
Kehoe and Dean
Boston, Mass.

Consulting Architects: McKim, Mead and White
New York, N. Y.


mech. service
T
jan.
stairs
battery rm.
store
stairs
stairs
elev.
vault
capacity 110/rm.
corridor
corridor
store
stairs
receiving
mech.
T
Scale: 10 0 10 20 40 80

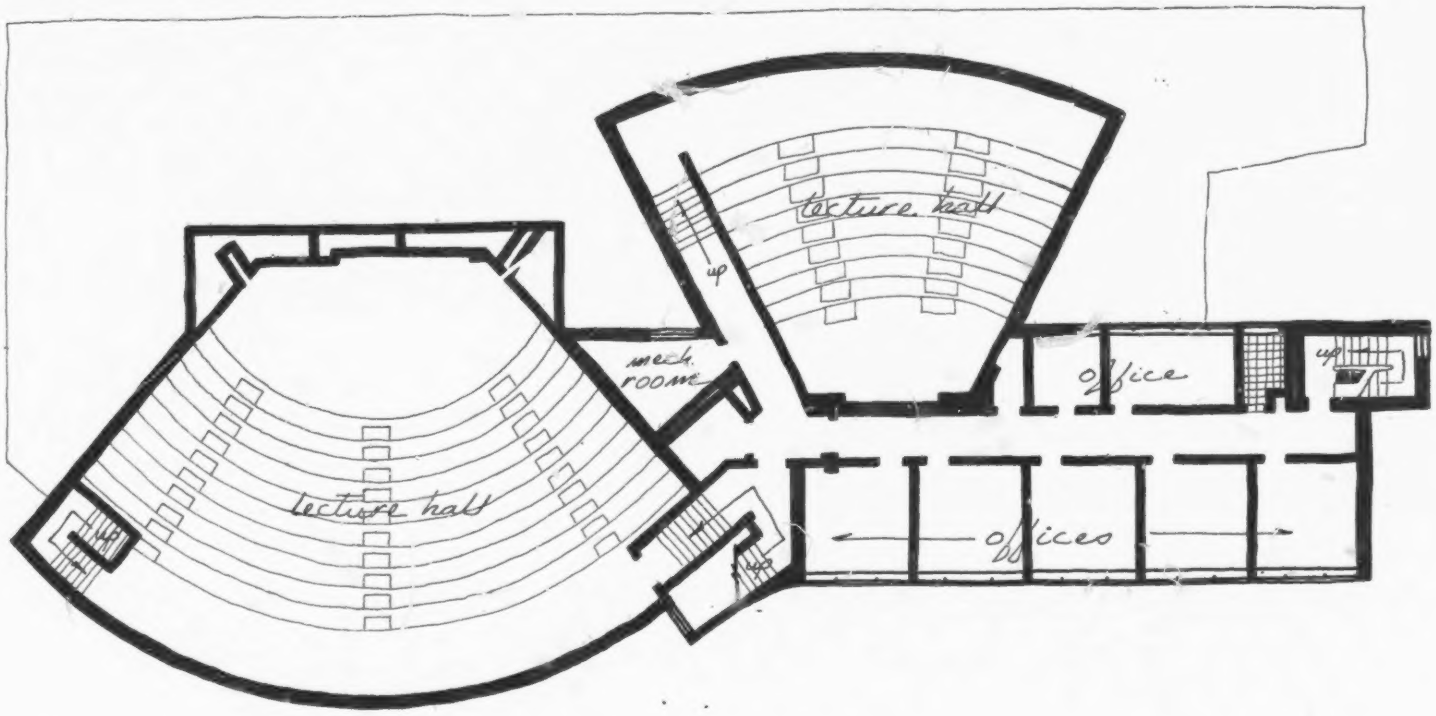
Ground Floor Plan

Ground Floor Plan
Aldrich Hall, Harvard Business School
Harvard University

The plan shows a number of the case-study rooms, described previously, arranged into a building form. The shape of the rooms, when they are put side by side, permits the classroom access to be off an entry alcove instead of directly off the corridor. Each classroom is also accessible from either hallway permitting quicker filling and emptying during class changes. The building contains 17 classrooms on three floors, with the classroom capacities varying from 80 to 160. Of particular interest is the fact that a full size model of one of the rooms was "mocked-up" and tried out before the building was finally built.

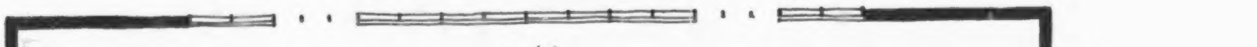
Architects: Perry, Shaw and Hepburn
Kehoe and Dean
Boston, Mass.

Consulting Architects: McKim, Mead and White
New York, N. Y.


lecture hall
up
mech. room
office
up
lecture hall
up
offices
up

Plan

Scale: below


lobby
up
lecture hall
lecture table
above
storage
lecture table
lecture hall
lecture hall
lecture table
up
up
T
T
down
corridor
down
loading platform

Plan

Scale: 5 0 5 10 20 40

Second Floor Plan
Allston Burr Lecture Hall
Harvard University

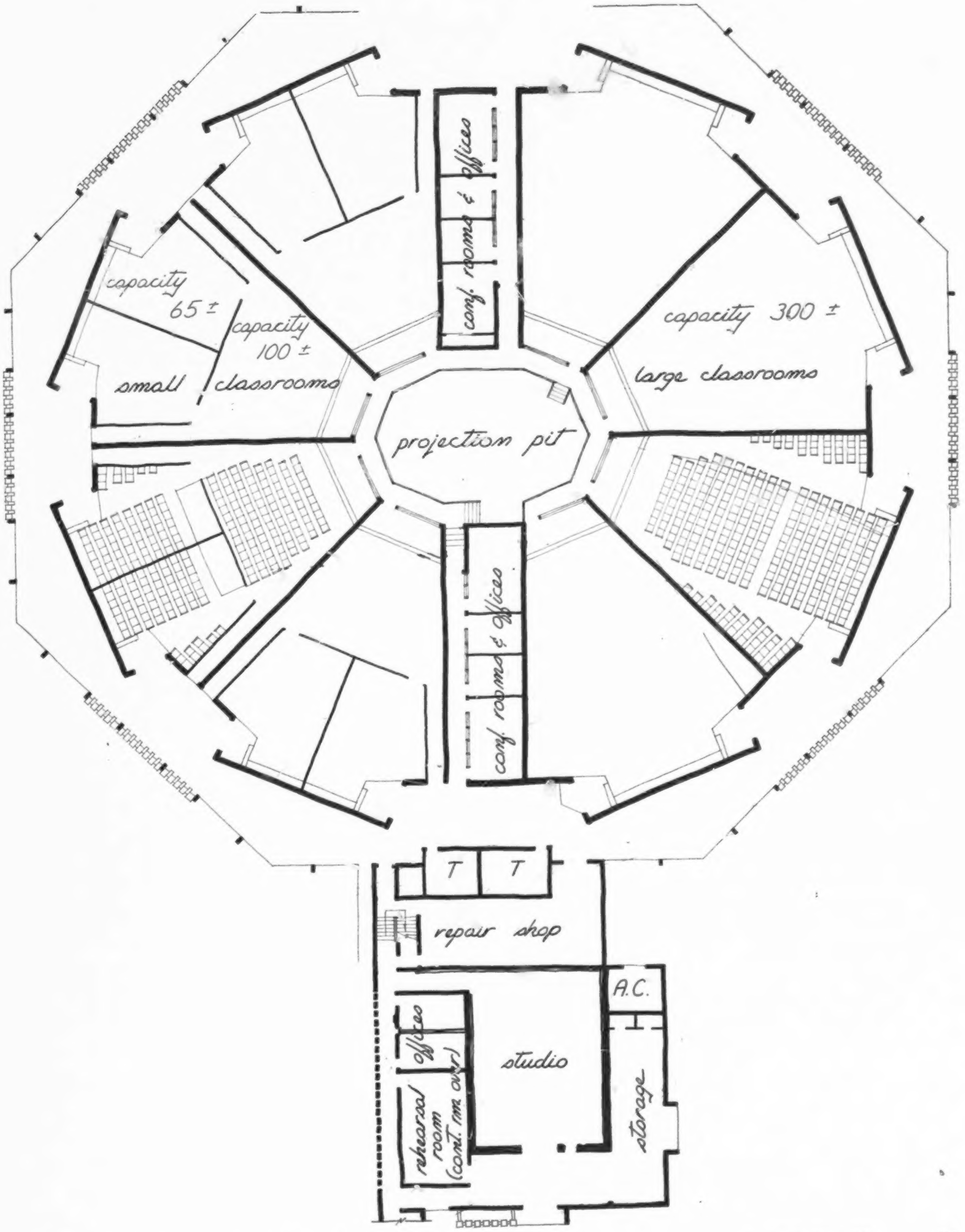
Allston Burr was designed primarily for teaching the large-enrollment physical science courses in the general education program at Harvard, and therefore the facility includes preparation and storage areas to support lecture-demonstrations. The two lecture rooms have capacities of approximately 200 and 400 with theatre-type seats arranged in tiers giving a slope of over 30°. The space resulting from the steep slopes beneath the lecture halls contains small classrooms and a lobby. The lecture rooms have chalkboards across the front and demonstration tables with connections for power, gas, compressed air, water and exhaust. Film materials are projected from the rear and the lecture hall lights are controlled from four panels, one located at the projection stand. Down-lights permit students to take notes while slides are being shown. In the large lecture room, a curtain can be drawn to permit a demonstration to be set up while a class is in session; a chalkboard is lowered in front of the curtain.

Architects: Shepley, Bulfinch, Richardson and Abbott
Boston, Mass.

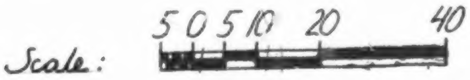
Main Floor Plan - Lecture Hall Wing
Physics Building, University of Maine

This wing contains three lecture halls, two of 92 capacity each and one of 244 capacity with common preparation and storage between. Each row of seating is raised 6" above the row in front and access to all the lecture halls is from the rear to avoid interference with equipment and demonstration apparatus located in the front. There are no particular features to permit extensive projection equipment in the spaces other than a moveable projection table.

Architect: Alonzo J. Harriman, Inc.
Auburn, Maine


conf. rooms & offices
capacity 65 ±
capacity 100 ±
small classrooms
capacity 300 ±
large classrooms
projection pit
conf. rooms & offices
T
T
repair shop
A.C.
offices
studio
rehearsal room (cont. rm. over)
storage

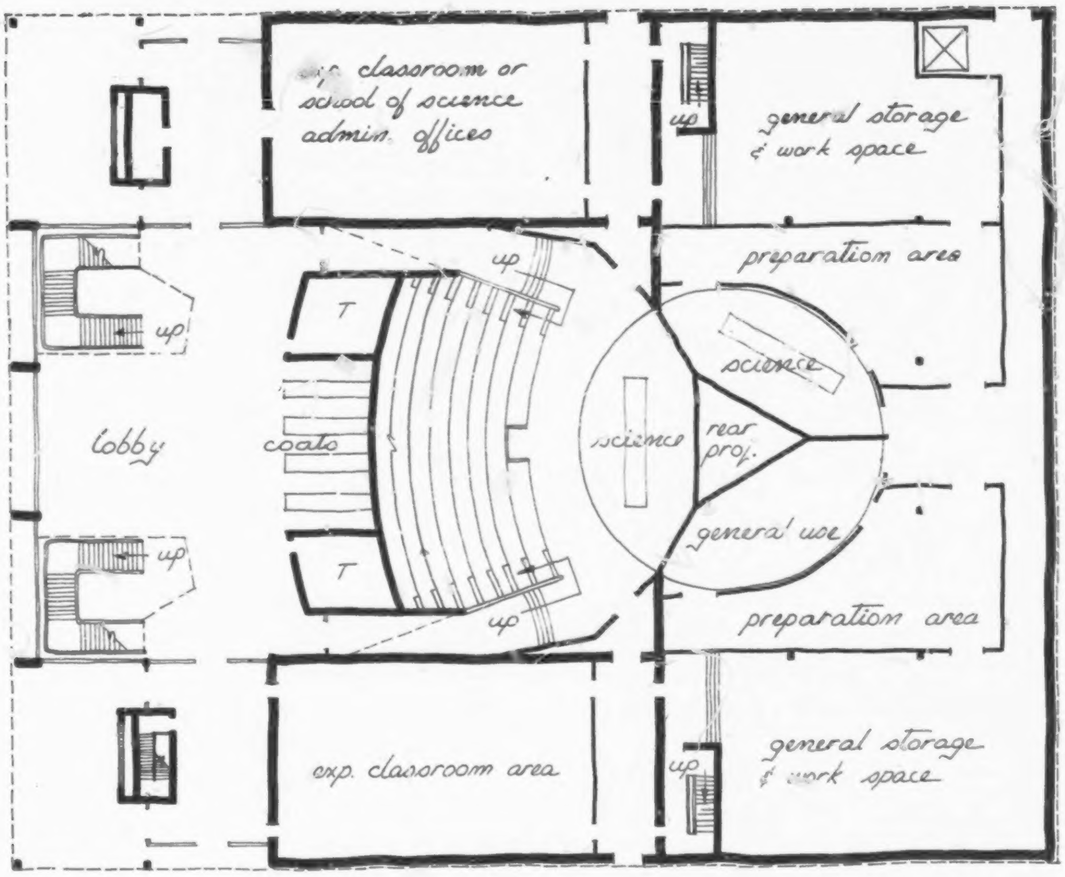
Classroom & Studio Building


Scale:
5 0 5 10 20 40

Classroom and Studio Building
University of Miami, Florida

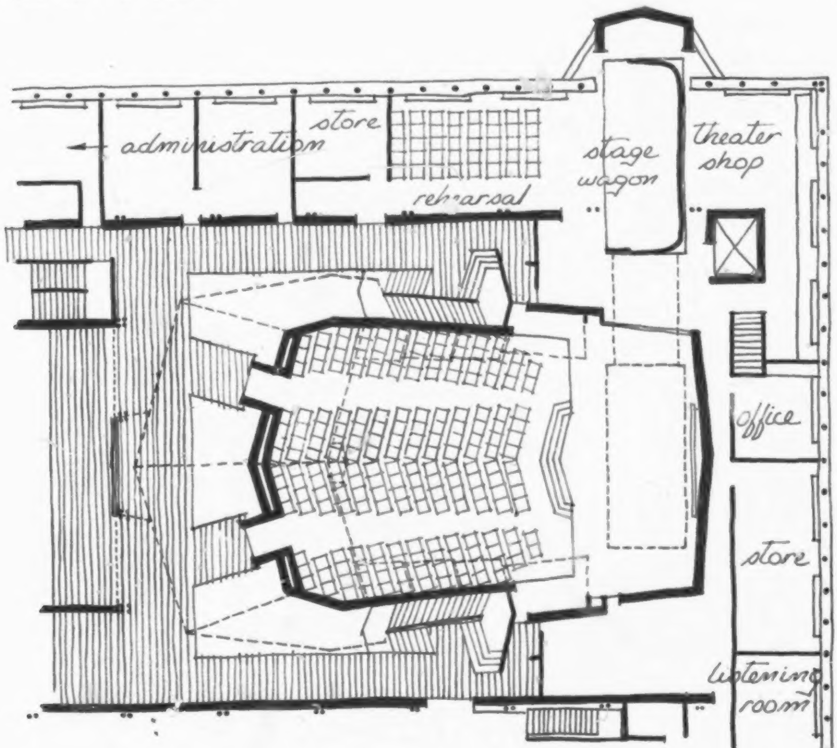
This original plan indicates a basically circular scheme comprised of 4 large classrooms with capacities of approximately 300 each and 12 smaller classrooms of 65 to 100 each arranged around a central projection area. As built, the building contains 6 large classrooms and 6 small ones. Eventually it will contain only the 8 large rooms. From the projection area films, slides, and television are rear-projected into the surrounding classrooms. Sound isolation between the classrooms and the projection area is achieved by a flexible screen and fixed glass. The floors in all the classrooms are sloped for improved viewing. A television studio is located in a wing of the building from which televised instruction can originate and be viewed in one or more of the classrooms. A two-story "spine" containing offices, conference rooms and storage runs through the center of the building. Access to all the classrooms is from an open corridor surrounding the building.

**Architect:** Robert Fitch Smith, F.A.I.A.
Miami, Florida


exp. classroom or school of science admin. offices
up
general storage & work space
up
preparation area
up
T
science
lobby
coats
science
rear proj.
general use
T
up
up
preparation area
exp. classroom area
up
general storage & work space

Main Floor Plan

Scale: below


administration
store
rehearsal
stage wagon
theater shop
office
store
listening room

Main Floor Plan

Approx Scale: 10 0 10 20 40 80

Proposed Auditorium - Science Center
Rensselaer Polytechnic Institute

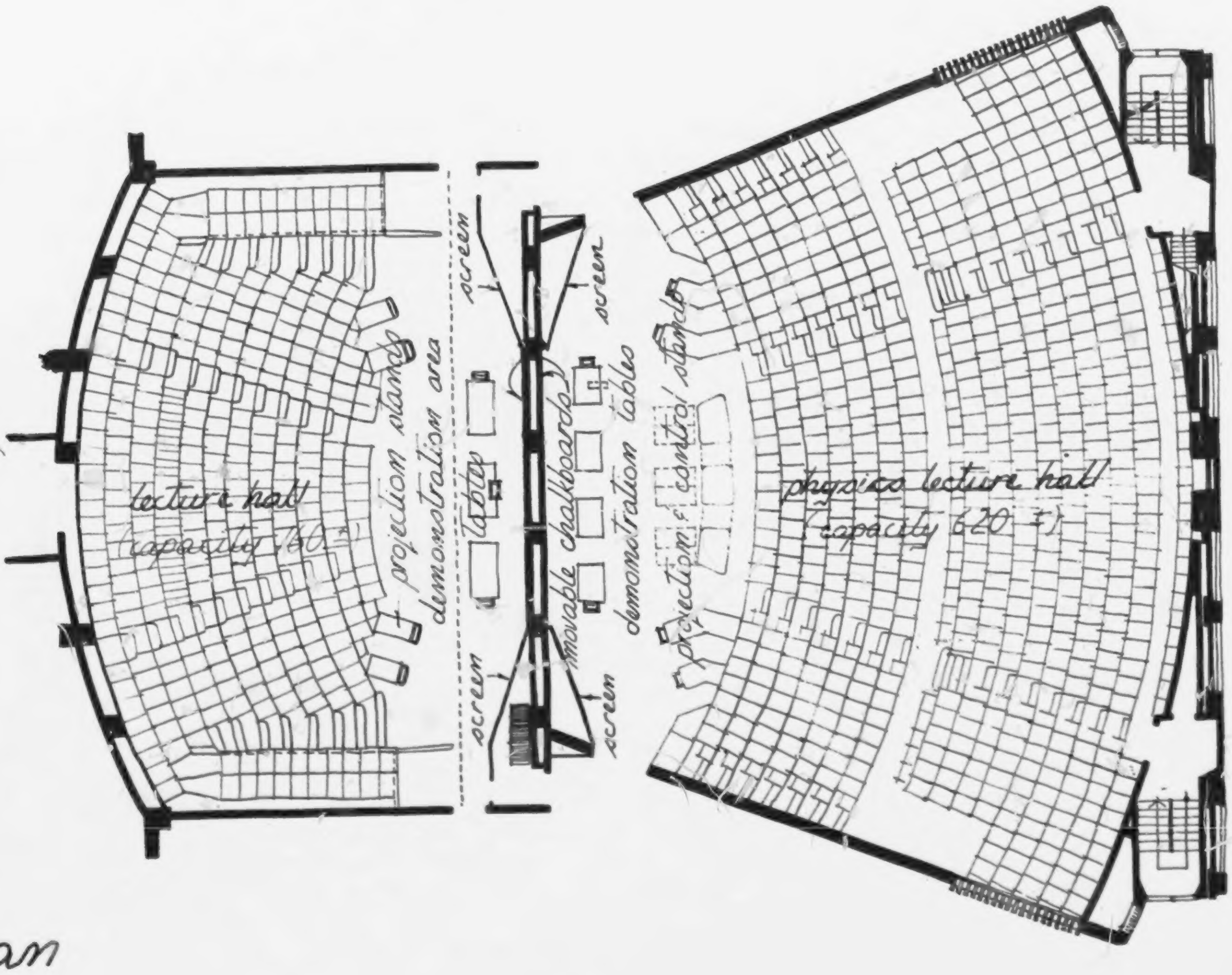
This is an early study for a teaching auditorium designed principally for science lecture-demonstrations. With a capacity between 400 and 500, its primary feature is a three-part turntable stage provided to increase the utilization rate of the space. While one lecture is being presented, two other demonstrations can be set up, and rotated into place during the break between classes. Above the center core of the stage is an area for rear-projection equipment. It has been contemplated that closed-circuit television will be used in the auditorium for magnification as well as for origination and recording for additional campus use.

Architects: Voorhees, Walker, Smith, Smith and Haines
New York, N. Y.

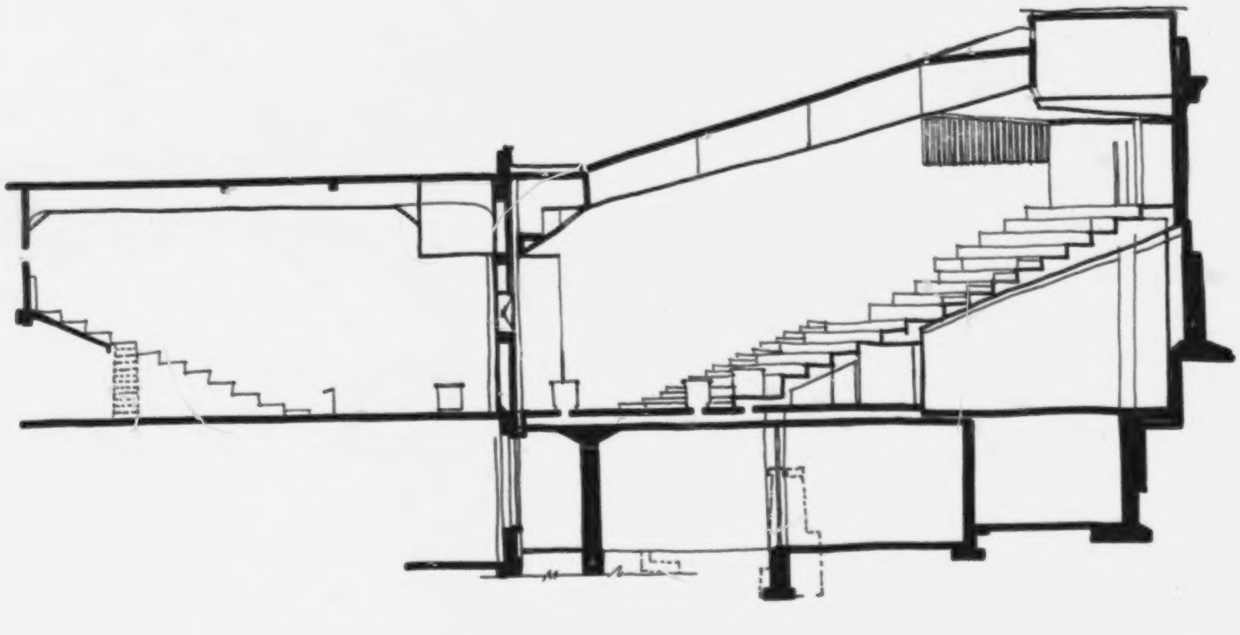
Auditorium - Jewett Art Center
Wellesley College, Mass.

Although this facility was not designed as a teaching auditorium as such, it is of interest and pertinent to this study due to the use of a sliding stage. The "stage wagon" can be set up and used for rehearsals and then moved into the auditorium for the actual presentation. This same concept is apparently valid for lecture-demonstration facilities; the demonstration can be set up prior to class and moved on during the break. This is one method for increasing the utilization rate of large auditoria.

Architects: Paul Rudolph
Anderson, Beckwith and Haible
Associate Architects


lecture hall
(capacity 160±)
projection stands
demonstration area
tables
screen
screen
movable chalkboards
demonstration tables
screen
screen
projection & control stands
physics lecture hall
(capacity 620 ±)

Plan



Cross Section

Scale: 5 0 5 10 20 40

Physikal Institut and der E.T.H.
Zurich, Switzerland

This illustrates two back-to-back lecture halls, the older one on the left with a capacity of 160 and the newer one on the right with a capacity of over 600. The large hall was designed specifically for physics lectures, and since maximum utilization was not a significant factor no attempt was made to include multiple stages. Storage rooms are located near the hall, and apparatus and equipment is brought in and set up prior to a lecture, and taken down when the lecture is over. This ties up the auditorium for several hours before and after each lecture. A number of demonstration tables, each with several very complete utility and control panels, are located across the front of the hall, as well as projection stands and controls. Chalkboards and screen-areas extend across the front wall. The seating consists of continuous writing surfaces with fold-down seats. Of particular interest is the relatively steep slope of the seating as shown on the section.

Architect: A. H. Oeschger
Zurich

# FACTORS IN DESIGN

## C. Production Facilities

Any institution which begins to incorporate the aids and media into its instructional process, will eventually become involved in the production of the supporting materials. This production function may be very limited -- the making of charts and graphs, transparencies for the overhead, and the like -- or it may become a very extensive operation including the production of materials for all types of aids and media -- slides, motion pictures, models and apparatus, complete live television origination, kinescopes, audio and video tapes. Obviously the facilities to house these production activities vary widely as to function, complexity, size and relationships.

Since the primary emphasis in this report lies in the area of the learning spaces, design analyses and studies for the production facilities have not been developed in any great depth. They are presented primarily in diagramatic form as a means of indicating:

1. Functions and corresponding spaces required for three basic kinds of production:
    a) instructional materials production
    b) television production
    c) combined production
2. Functional relationships of the spaces within these units.
3. Significant design features of certain spaces.

Film production, television origination and other instructional materials production processes are really manufacturing processes -- and as such have a beginning, an end, and a number of intermediate steps. This report attempts to define the steps in the processes by defining the corresponding spaces.

Production facilities will vary greatly from campus to campus. At the present time many institutions with production units have located them in existing spaces, often scattered about the campus. Because many of the supporting elements in the production process serve more than one type of production, the trend will probably be in the direction of multi-use facilities serving an entire campus complex. In turn, the facility may become a part of a large, centralized, instructional service complex. It is also conceivable that in the future a number of campuses will utilize jointly a common production center, as a means of alleviating the high initial and operating costs of such facilities.

## 1. Instructional Materials Production

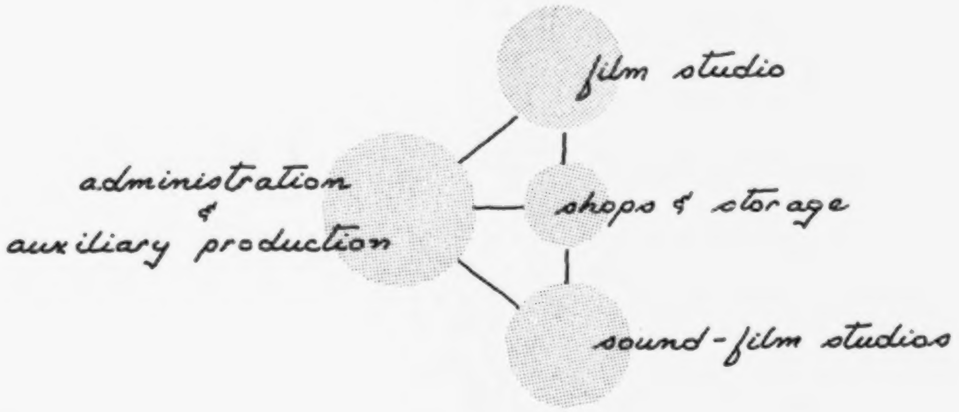
This unit functions to produce instructional materials such as:

- film materials -- motion pictures, slides, film loops, photographs and transparencies for the overhead projector.
- audio tapes.
- graphic-art materials -- charts, graphs, visuals and other opaque displays.
- three-dimensional aids -- large-scale models and demonstration apparatus.

The production of these materials is a service to the teaching faculty. The production process is initiated by a conference between faculty members and the production staff at which time the instructional requirements of the materials are defined and specifications and a production schedule are set up. After the necessary production steps the finished materials are distributed to the faculty concerned. Eventually the material may be deposited in the Instructional Materials Access Center where it is available to the student for review; it may also be distributed to cooperating institutions.

The spaces and functions in a typical unit are indicated in the following diagrams. Obviously some of the functions may result directly in end products (i.e. the making of a graphic chart) or may constitute intermediate steps in a more complex production process (i.e. the graphic chart may be photographed and used in a motion picture). Because of this diversity of requirements an arrangement of spaces to provide a straight-line production process is not completely valid.

An Instructional Materials Production Unit may be considered to consist of four basic components as shown on the functional diagram below.

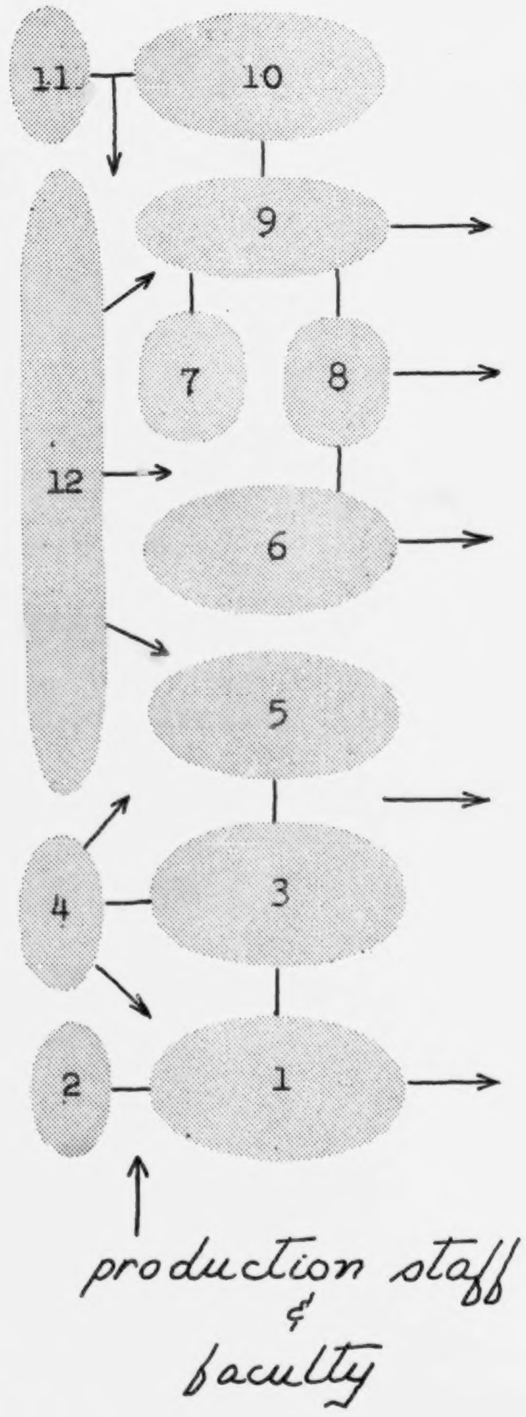


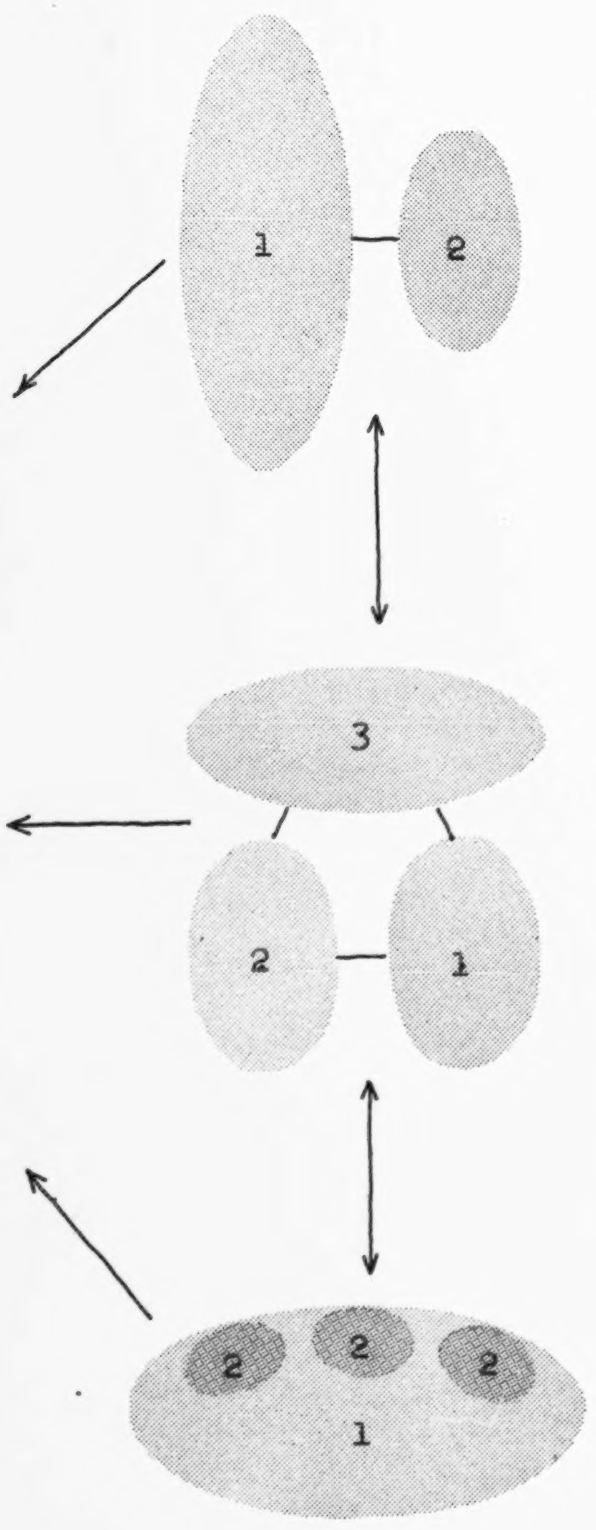
Production Facilities

The spaces and functions within the four components may be:

## administration - auxiliary production

1. Clerical and shipping - location of receptionist, secretaries and personnel involved in distribution of materials.
2. Film vault - storage of completed film materials.
3. Conference-rehearsal - rooms for faculty-production staff conferences, rehearsals prior to recording or filming, and periodic staff conferences.
4. Production staff offices.
5. Recording and radio studios - making of audio-tapes, dubbing of sound on films and possibly radio broadcasting.
6. Graphic-art studio - production of graphs, charts, "visuals" and some slide materials for both direct classroom and film production use.
7. Still photography.
8. Animation - filming of art work.
9. Processing - darkrooms for limited developing and printing of film materials.
10. Editing-assembly - editing of motion pictures and assembly of all instructional materials.
11. Previewing - small projection rooms for viewing incomplete as well as finished film materials.
12. Offices, storage, and toilets - located as needed adjacent to the various production areas.





## film studio

1. Film studio - a large, open studio for the filming of silent motion pictures on which the sound may later be added. The studio can be flexibly divided into filming areas by using demountable flats. This will permit simultaneous filming of one or more productions.

2. External slab - concrete slab (possibly covered) adjacent and accessible to the studio for external filming. It may also be used as a receiving platform for materials taken directly into the studio.

## shops and storage

1. Model and set shop - production of models and demonstration apparatus for direct instructional or production uses, and the making of sets and flats for use in the studios.

2. Storage - a large area for storage of materials used in the studios or awaiting distribution for classroom use.

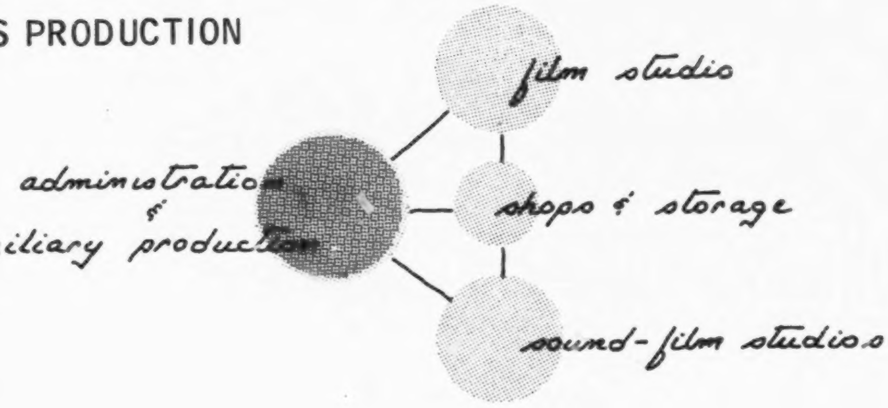
3. Equipment receiving, storage and maintenance.

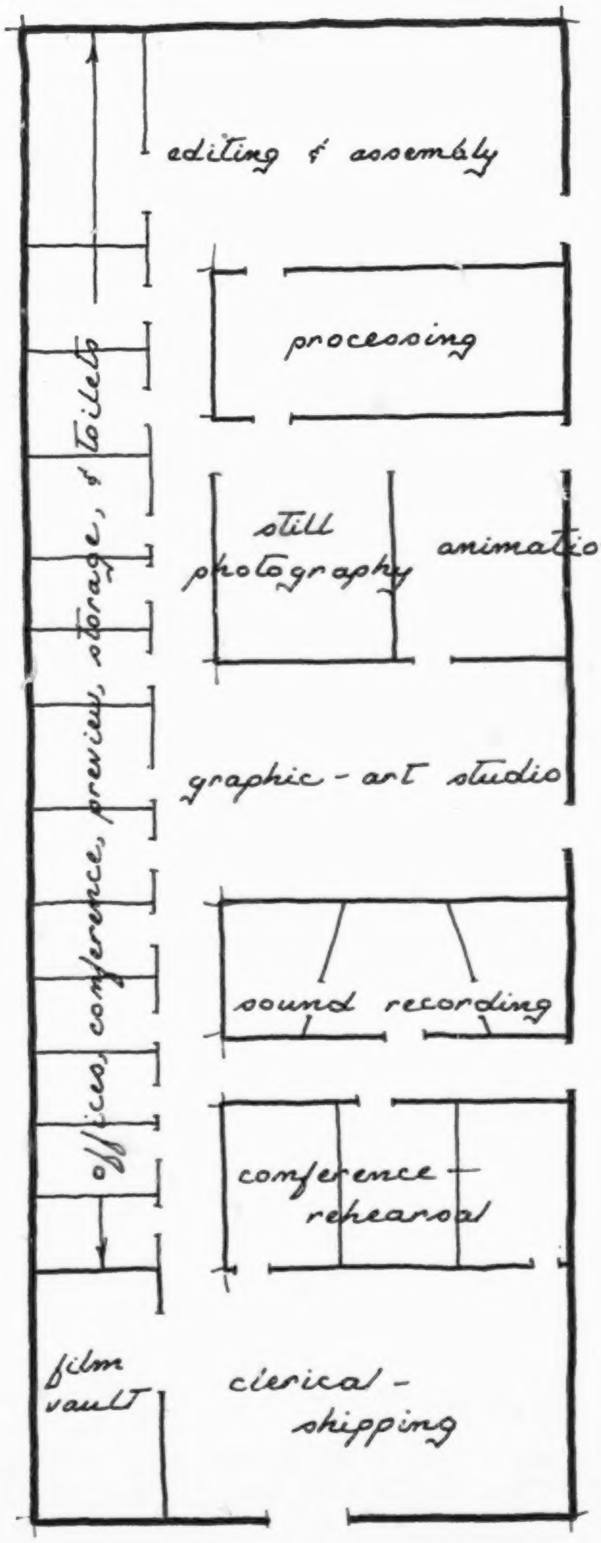
## sound-film studios

1. Sound studios - several studios in which both the sound and image are recorded simultaneously. This permits only one production at a time per studio.

2. Control-engineering - glass-fronted booths accessible to each studio for control-engineering personnel and equipment.

## INSTRUCTIONAL MATERIALS PRODUCTION
### Architectural Considerations


film studio
administration & auxiliary production
shops & storage
sound-film studios


editing & assembly
processing
still photography
animation
graphic-art studio
sound recording
conference-rehearsal
offices, conference, preview, storage, & toilets
film vault
clerical-shipping

Ceiling height - 9 to 10 feet throughout this component as no functions require any greater height.

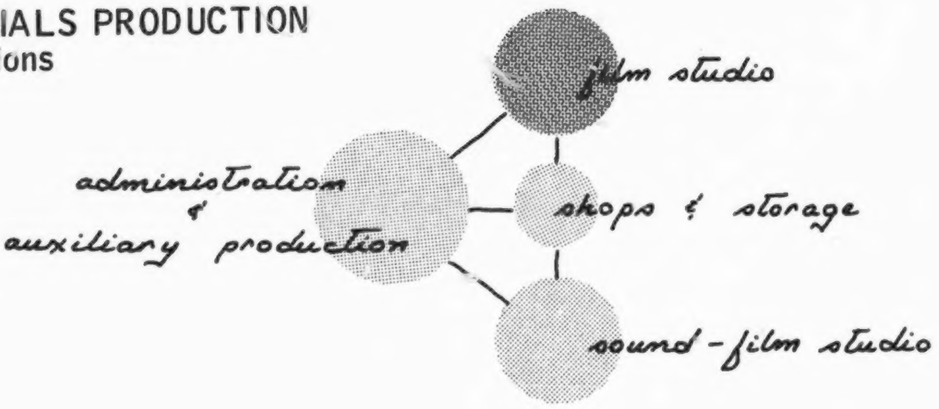
Lighting - must be carefully considered in each of the spaces due to the diversity of activities. (ranging from the graphic arts studio to the darkrooms). With the exception of the offices, daylighting does not appear beneficial.

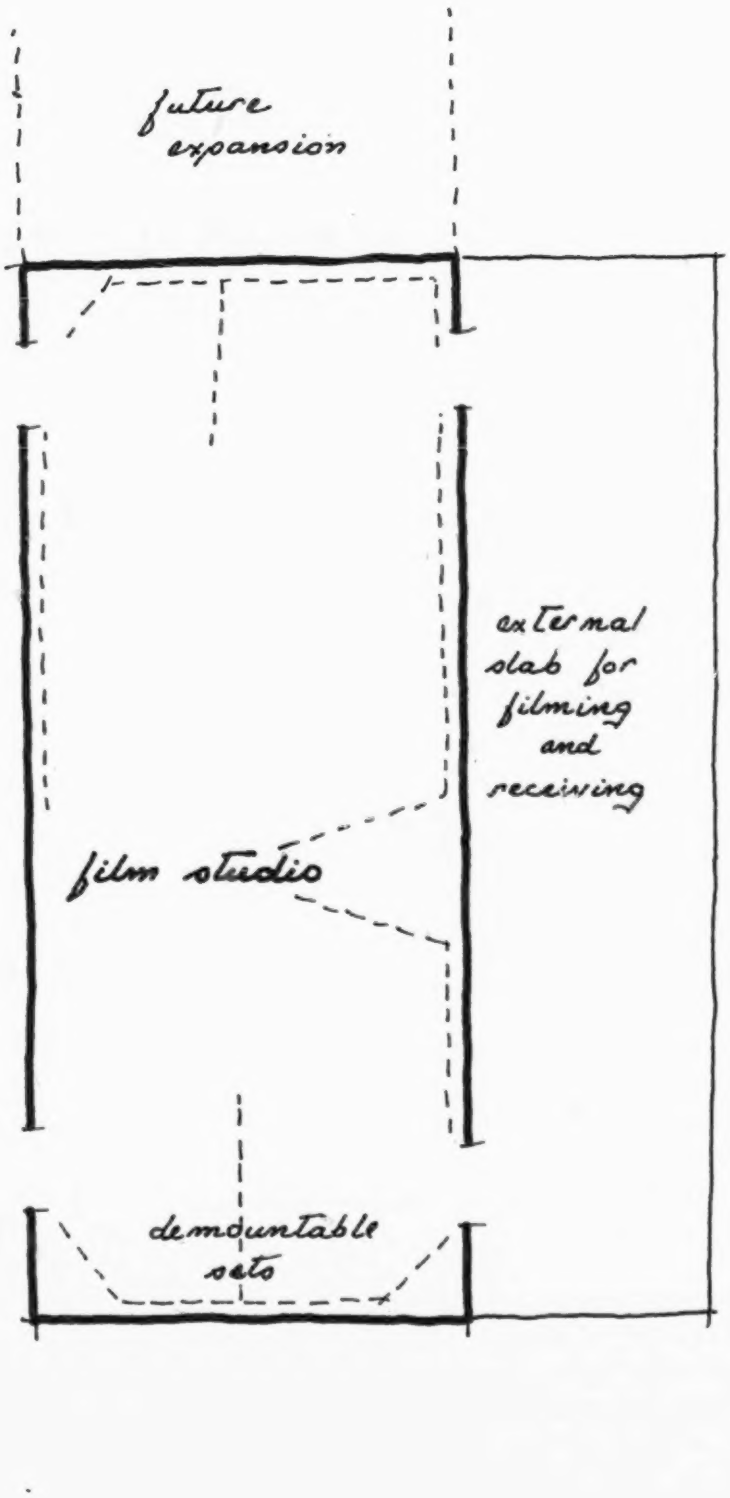
Air-conditioning - air-conditioned throughout.

Partitions - non-bearing demountable partitions desirable particularly in the office, conference and clerical areas. This would facilitate future rearrangement of these spaces.

Sound isolation - recording studios and preview rooms sound isolated. In the other areas disturbing sound interference between adjacent spaces and functions should be avoided.

## INSTRUCTIONAL MATERIALS PRODUCTION
### Architectural Considerations


film studio
administration & auxiliary production
shops & storage
sound-film studio


future expansion
external slab for filming and receiving
film studio
demountable sets

Ceiling heights - a minimum of 12 to 14 feet clear height to the bottom of catwalks, lighting grids, etc.

Lighting - quantity, quality and location of studio lighting important. It should be installed to permit flexible arrangement of the fixtures as needed by a particular set. This can be accomplished by a suspended pipe grid and catwalk on which the required lighting is set. Sections of the grid should be designed to be lowered for low angle lighting.

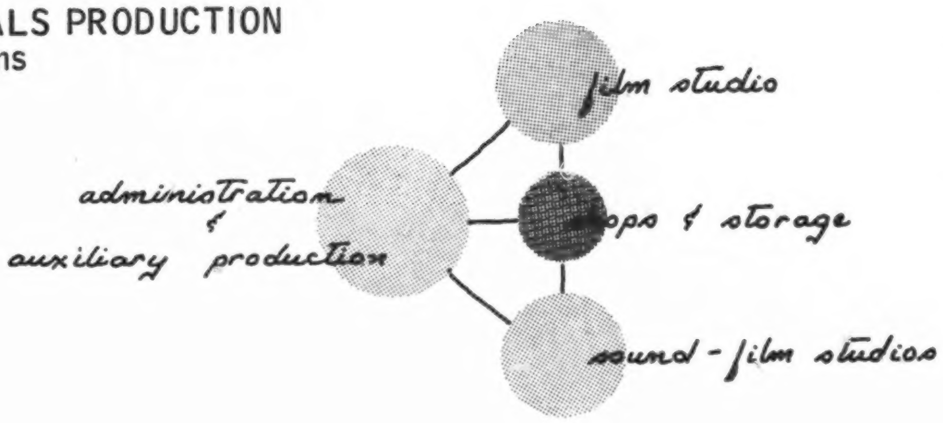
Air-conditioning - adequate air handling essential due to the high heat output of the lights and equipment.

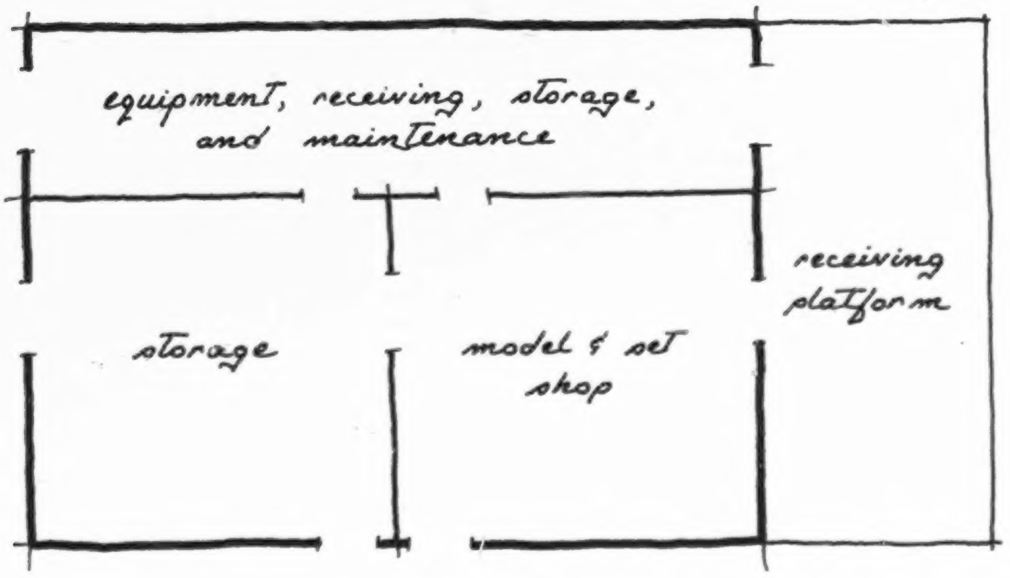
Acoustics - within the film studio sound control. not critical as no sound is being rec orded.

Access - overhead doors to the slab area. These are necessary for bringing large pieces of equipment onto the studio floor, and for moving camera equipment outside for external filming.

## INSTRUCTIONAL MATERIALS PRODUCTION

### Architectural Considerations


film studio
administration
&
auxiliary production
ops & storage
sound - film studios


equipment, receiving, storage,
and maintenance
receiving
platform
storage
model & set
shop

Ceiling heights - 12 to 14 feet minimum due to the clearance required for building and assembling sets and flats used in the studios. This height also permits multi-level storage of smaller equipment and apparatus.

Lighting - good general lighting throughout with high intensity on special task surfaces such as work bench and table saw.

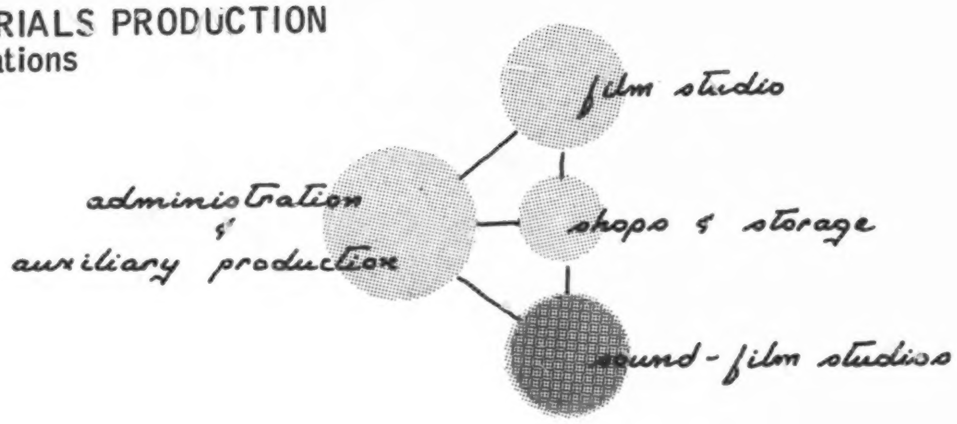
Air-conditioning - complete air-conditioning desirable; if not, a mechanical exhaust system is imperative.

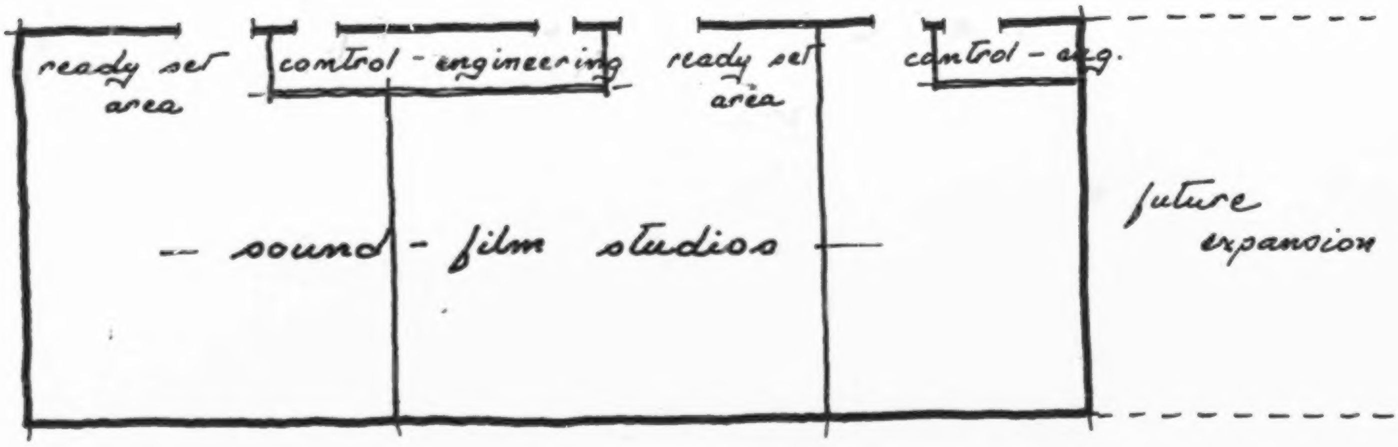
Sound isolation - sound isolated to prevent disturbing sounds escaping to the production areas.

Access - large doors (possibly overhead) opening from the receiving platform for bringing in materials and equipment. The doors through which equipment and sets are taken to the studios should also be wide and high. Level floors for easy movement of equipment, flats and sets are necessary throughout the entire Unit.

## INSTRUCTIONAL MATERIALS PRODUCTION

### Architectural Considerations


film studio
administration
&
auxiliary production
shops & storage
sound-film studios


ready set area
control-engineering
ready set area
control-eng.
sound-film studios
future expansion

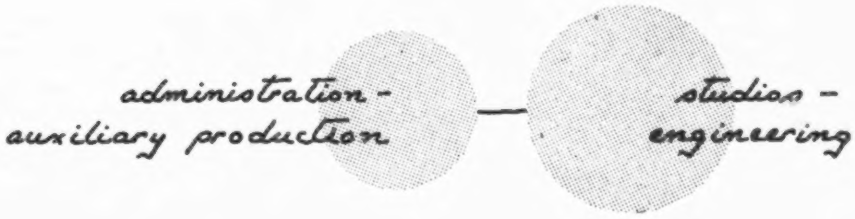
The design considerations for the sound-film studios are similar to those of the film studio, with one exception - acoustics. Since the sound is being recorded simultaneously with the picture, the studios must be completely sound isolated and reverberation carefully controlled to produce the best conditions for sound recording. Isolation is accomplished by dense partitions, double doors and other means of controlling leakage; reverberation is controlled by treating the interior surfaces with sound absorptive material. In addition noise-producing mechanical equipment should be located remote from the studios with any connecting ductwork carefully baffled.

## 2. Television Production

This unit is designed for originating televised instruction which is distributed to a number of receiving points on the campus or to cooperating institutions. The unit may fulfill a number of related functions such as reception and distribution of "off the air" programs, recording of televised instruction (video tape or kinescope), distribution of film materials, and coordinating of remote origination from labs, research centers and other potential "studios". These related functions affect space considerations only as far as requirements of engineering and control, and materials and equipment storage. Distribution of the television image may be either by open or closed-circuit or both; the method of transmission does not basically affect the design of the facility.

The unit will probably serve an entire campus, or possibly, in the case of the large university, one or more colleges on the campus. Depending on the scope and philosophy of televised instruction in an institution, the television unit may be very elaborate, or quite simple. In present usage, as represented on several campuses, the television studios themselves may be decentralized throughout the campus in new or remodelled existing spaces.

The accompanying diagrams illustrate a centralized facility with all studios and related functions housed in a single unit. The unit can be thought of as comprising two components; administration-auxiliary production, and studio-engineering. The auxiliary production may produce materials such as visuals and models for direct classroom use, as well as for use in the studios.



F

Production Facilities

The spaces and functions within the two components may consist of:

administration - auxiliary production

1. Reception and secretarial - space for secretarial staff and reception area for visitors.

2. TV faculty offices - offices for faculty members instructing by television and provided to permit coordination between "on-camera" faculty and production staff. (The faculty may also have academic offices elsewhere on the campus.)

3. Production staff offices.

4. Conference rooms - spaces for planning and programming.

5. Film and graphic materials storage - storage of materials used by the faculty in preparation and presentation of televised instruction and includes space for previewing projected materials.

6. Graphic arts studio - production of art work and visuals.

7. Still photography.

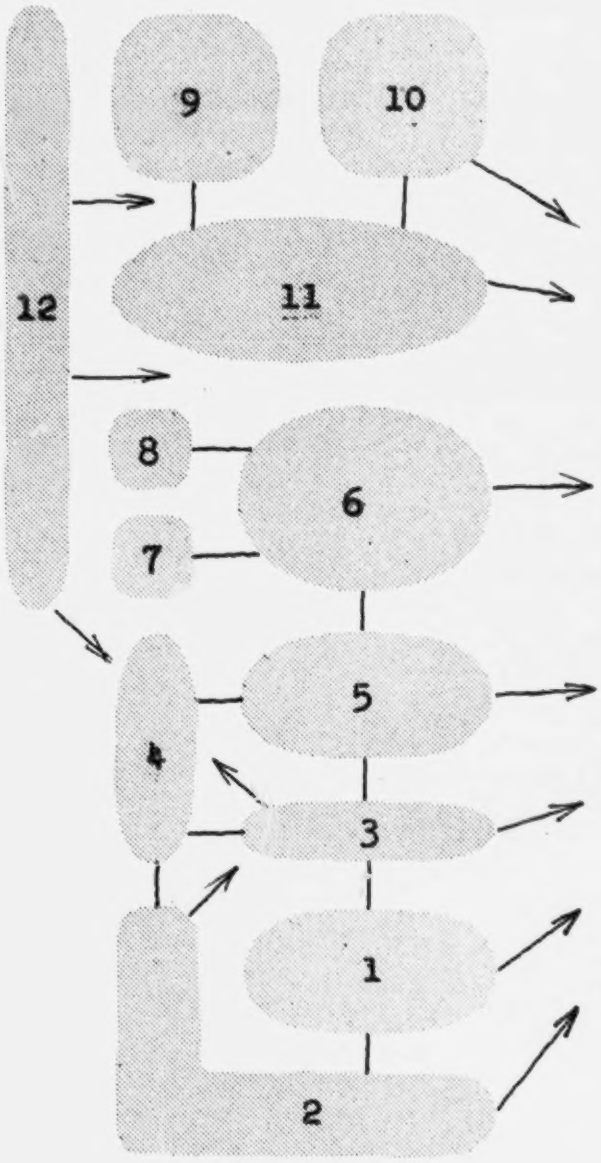
8. Processing - darkrooms for limited processing of film materials.

9. Workshop - making or assembling of models, sets, flats and apparatus for studio use.

10. Equipment shop - receiving, maintenance and storage of camera, sound, control, lighting and other production equipment.

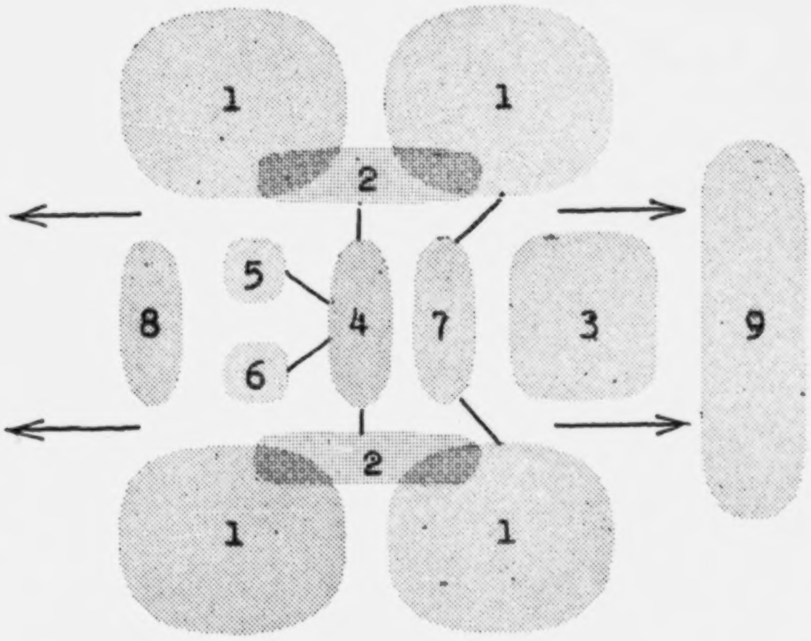
11. Storage - Large area for flats, sets, apparatus, and other production materials.

12. Offices, storage, toilets and mechanical equipment areas - located as needed throughout the unit.



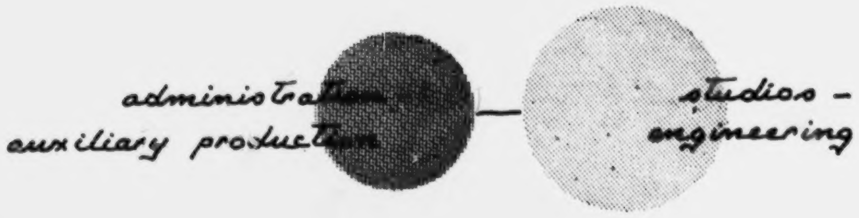
## studios - engineering

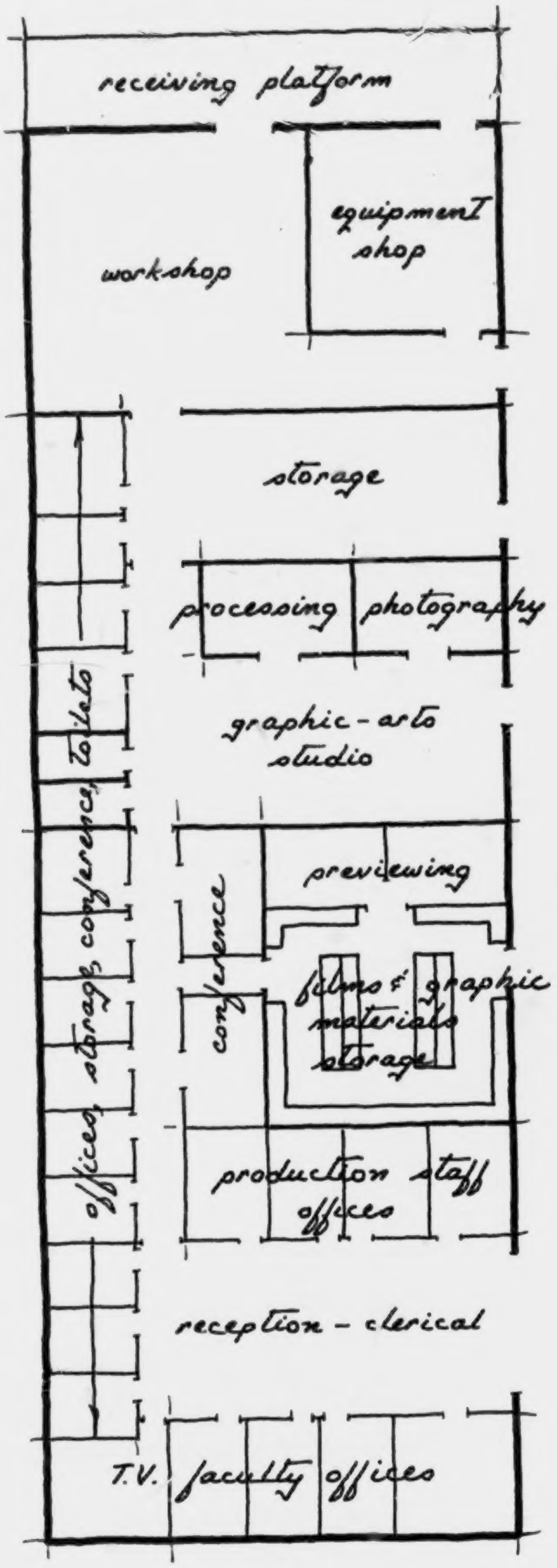
1. Television studios - origination of televised production. The size, location and functioning of the studios will vary depending on the philosophy and scope of televised instruction.
2. Studio control - glass-fronted booths which serve one or more studios and house the producer-director and control equipment. (Booths do not require direct visual contact with studios; control may be handled by monitors.)
3. Storage - adjacent to the studios to avoid loss of production areas within the studios given over to storage.



4. Central control, engineering and distribution - electronic "nerve center" for receiving "off-the-air", coordinating remote and studio signals, and maintaining control of all origination and distribution.
5. Projection - location of camera chains for distribution of film, slide, and opaque materials.
6. Recording - location of kinescope or video tape recorders.
7. Equipment storage - storage of camera equipment available for studio use.
8. Dressing and make-up areas.
9. External slab - televising of equipment and apparatus too large or cumbersome to be moved into a studio.

## TELEVISION PRODUCTION
### Architectural Considerations


administration -
auxiliary production
studios -
engineering


receiving platform
workshop
equipment shop
storage
processing
photography
graphic-arts studio
offices, storage, conference, toilets
previewing
conference
films & graphic materials storage
production staff offices
reception - clerical
T.V. faculty offices

Ceiling height - 9 to 10 feet except for 12-14 feet in shop and storage areas.

Lighting - carefully designed to meet the requirements of particular spaces and functions. Daylighting could be considered in the office and conference areas, but may well be detrimental in the other areas.

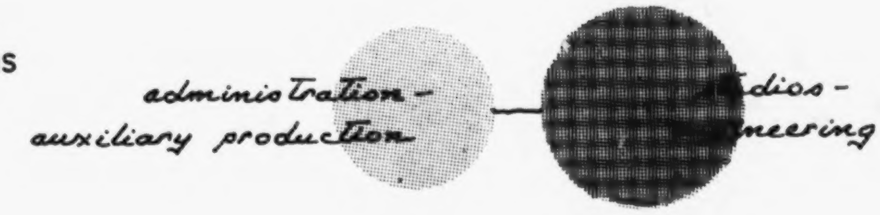
Air-conditioning - throughout to create optimum working conditions.

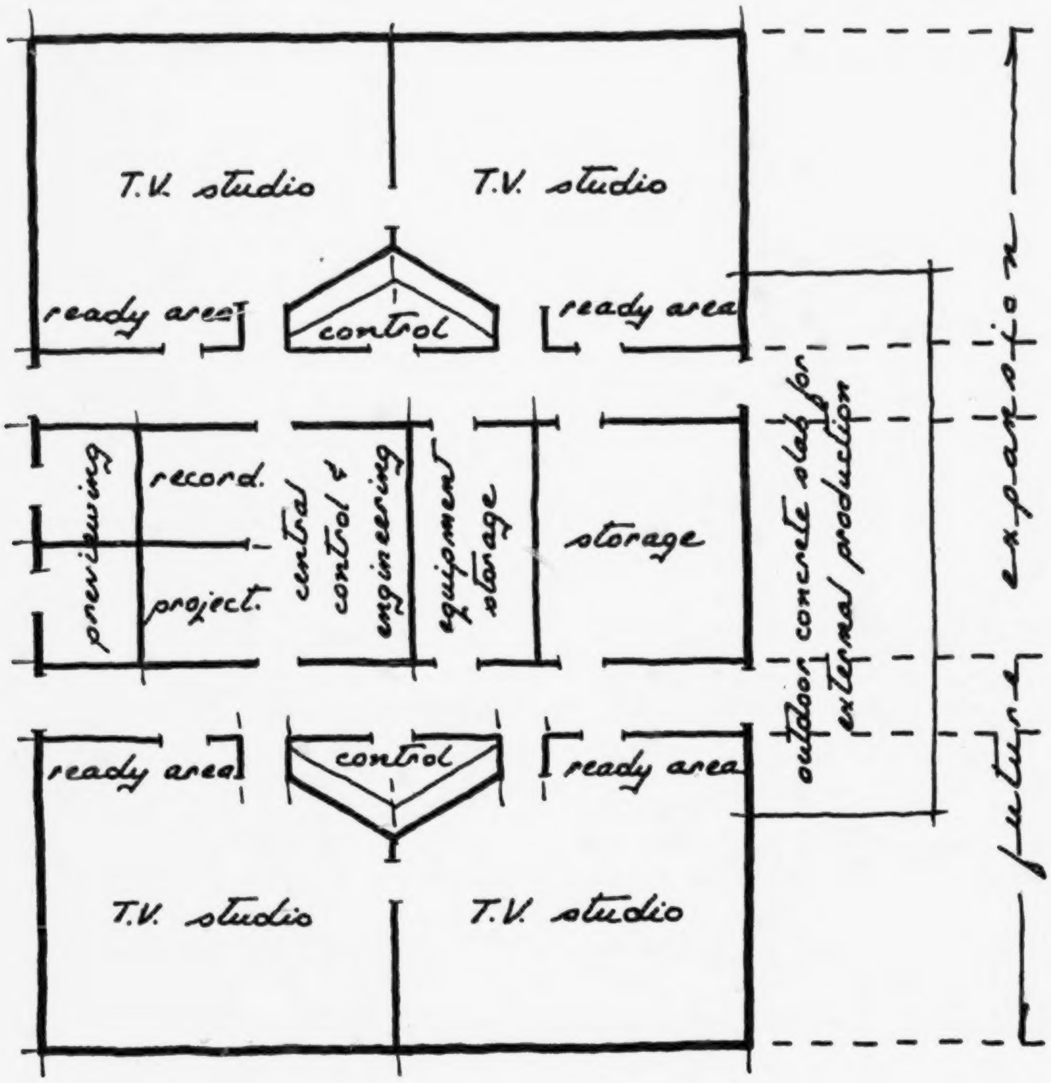
Partitions - demountable partitions used in office, clerical and conference areas would permit future reorganization of space.

Acoustics - shop and preview areas sound isolated. Sound control in other areas must permit non-interference with adjacent functions.

Access - large overhead doors necessary between shops and receiving platform. Wide, high doors are necessary wherever flats, sets and other large materials are being moved from shops and storage to studios. Throughout the entire unit, floors should be the same level to permit easy movement of materials.

# TELEVISION PRODUCTION
## Architectural Considerations


administration -
auxiliary production
dios -
neering


T.V. studio
T.V. studio
ready area
control
ready area
previewing
record.
project.
central control & engineering
equipment storage
storage
outdoor concrete slab for external production
future expansion
ready area
control
ready area
T.V. studio
T.V. studio

The design of the control-engineering and storage core is basically a matter of accommodating the necessary equipment and production staff; a discussion of their architectural considerations would not be significant here. The following discussion is based on the design of the studios themselves.

Ceiling heights - 12-14 feet clear heights are sufficient unless scenery is to be flown.

Lighting - flexible lighting systems capable of producing 150-250 footcandles on a set. This may be achieved by a suspended, easily accessible light grid, sections of which can be lowered for various effects.

Production Facilities

Air-conditioning - complete air-conditioning or at least an adequate ventilation system due to high heat output of required lighting.

Acoustics - sound isolated from interfering external noises. Any mechanical equipment should be located outside the studio and connecting ducts should be sound baffled. For good sound origination the studio should be acoustically deadened with absorptive materials.

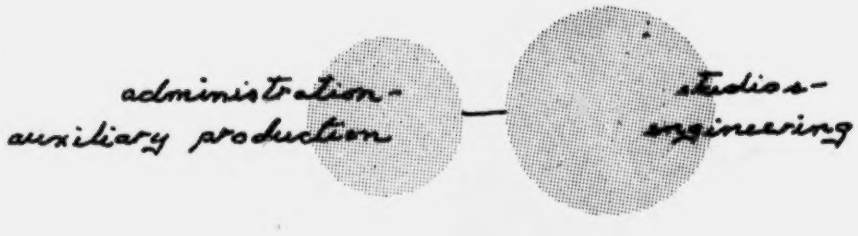
Access - large doors necessary for ease of moving sets and equipment in and out. An overhead crane from a loading platform may be desirable.

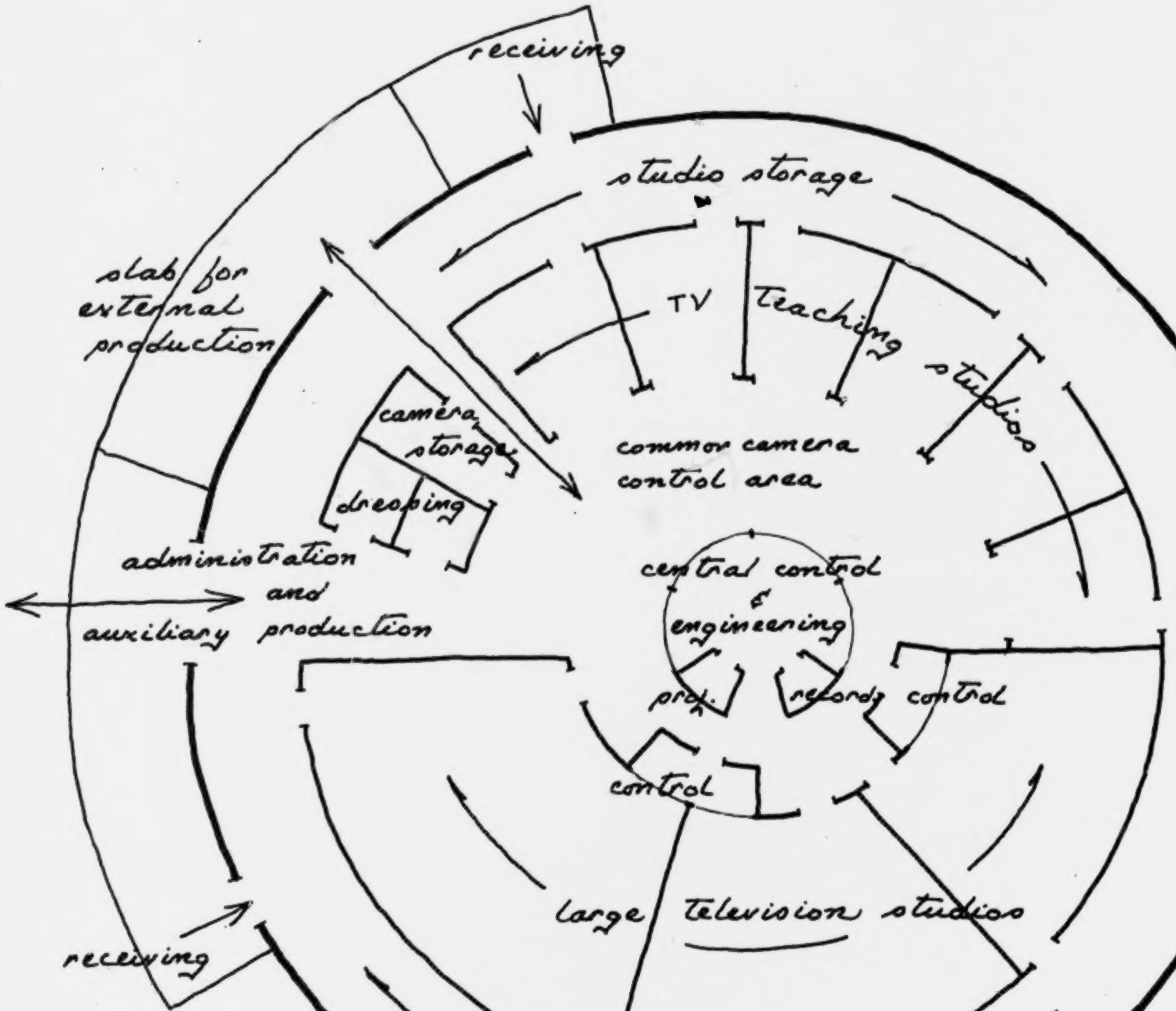
Planning - the studio scheme indicated previously is quite typical of the studios being used now for televised instruction - a large space with high ceilings, adjacent control room, and the possibility of only one production being televised at a time. The utilization of such studios may leave something to be desired as each studio is not only tied up during actual production, but also for setting-up, taking-down and rehearsal. This concept of studio design seems to be based on the needs of commercial television and does not necessarily meet the quite different needs of education.

Often televised instruction requires no elaborate set - possibly only a lectern, display rack for visuals, and a chalkboard - and as such requires only a relatively small studio. A number of such small studios could be set up on a semi-permanent basis, each with the equipment for a general type of instruction. Then there would not be the need for setting up and taking down the equipment each time a course is televised, and at other times the studio could be used for rehearsal. A television production center might consist, in part, of a number of small studios - one for physical sciences, another for natural sciences, a third for mathematics and so on - and the camera equipment might be arranged to permit its being moved from studio to studio as needed for rehearsal or actual televising. An additional concept suggests the use of a common camera-control area surrounded by a number of teaching studios.

There will probably always be a need for some large studios. Therefore, institutions may find that a variety of size studios, ranging from the large commercially-inspired to the small teaching-type is the most satisfactory solution in terms of flexibility of use. Based on these concepts, an additional scheme for the Studio-Engineering component of the television production unit is presented.

## TELEVISION PRODUCTION
### Architectural Considerations


administration-
auxiliary production
studios-
engineering

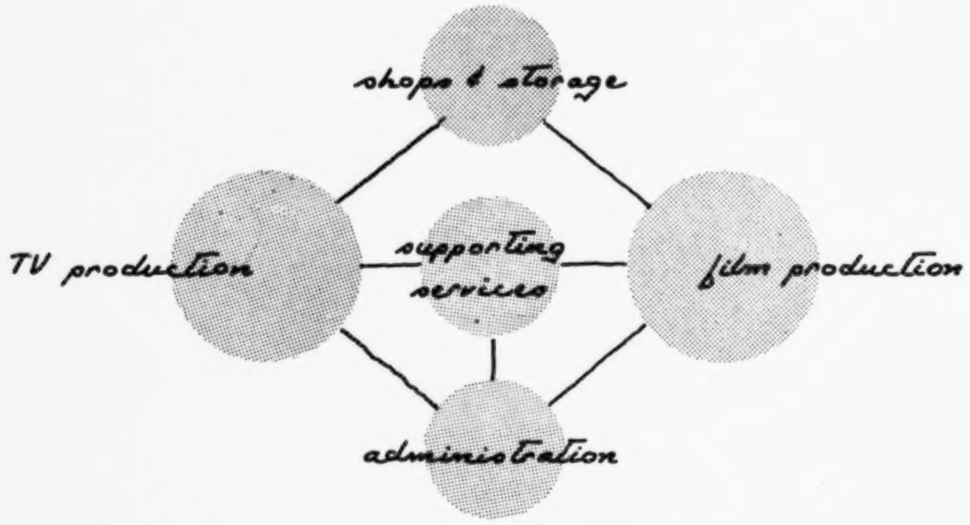

receiving
studio storage
slab for external production
TV teaching studios
camera storage
dressing
common camera control area
central control & engineering
administration and auxiliary production
proj.
records
control
control
large television studios
receiving
studio storage

## 3. Combined Production

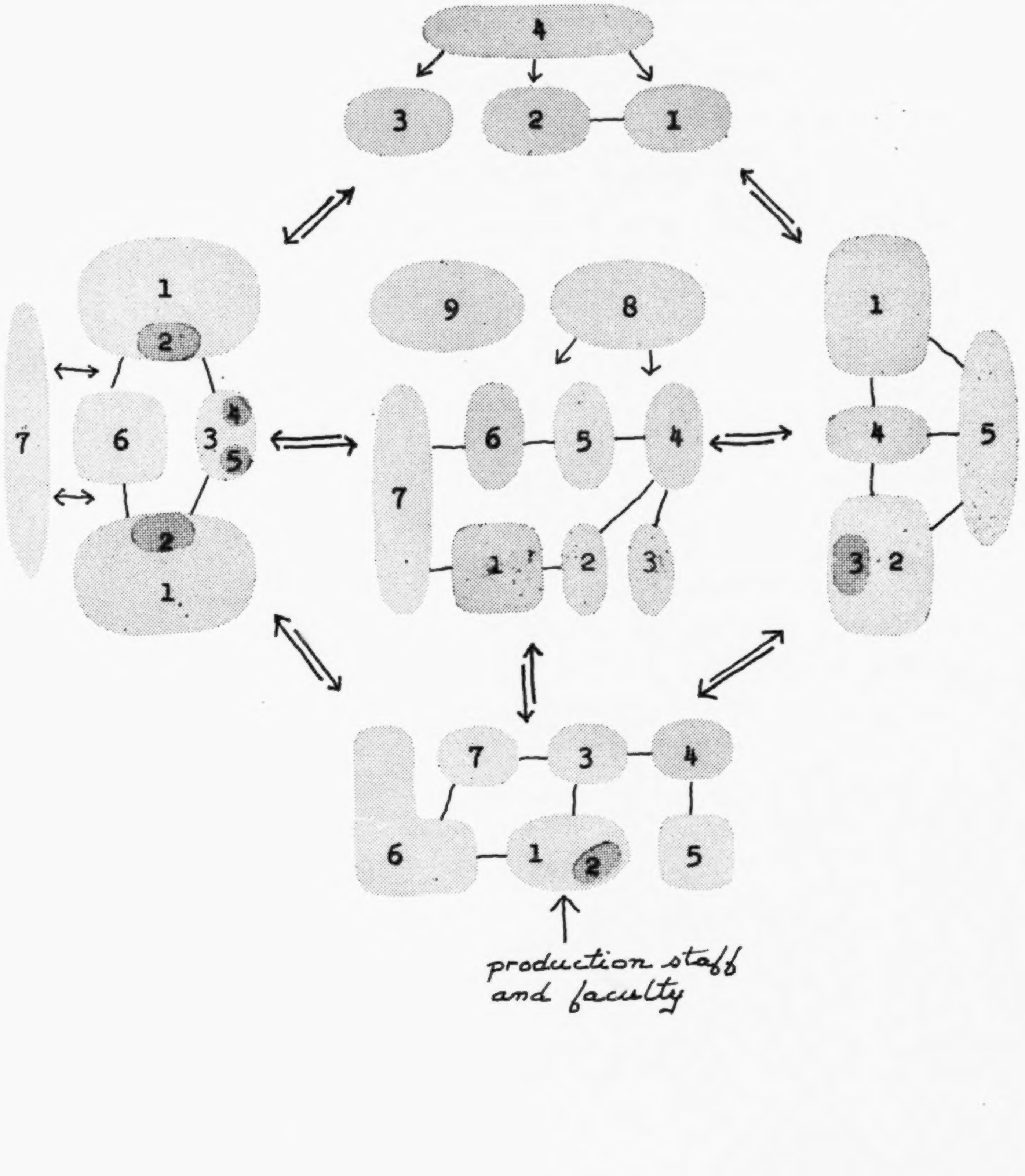
An institution venturing into a broad program of utilizing the aids and media in various campus instructional situations may well want to consider a single facility that combines all the production functions. In the long run such an approach can probably be justified from the standpoint of economy of space, equipment and personnel, as a number of functions can commonly support several production processes. As an example, a graphic arts studio can not only produce visuals and graphic materials for direct classroom use, but can also produce materials used in film production and television production.

In such a centralized facility the grouping of related spaces, and their relationship to other spaces constitutes the initial planning consideration. Since the previous discussions of the Instructional Materials and Television Production Units have defined the spaces and their functions, the following diagrams simply indicate an organization of similar spaces to achieve the required relationships for combined production.

Five related components contain the groupings of spaces and functions:



## COMBINED PRODUCTION
### Spatial Considerations


4
3
2
1
1
2
7
6
3
4
5
2
1
9
8
7
6
5
4
1
2
3
1
4
5
3
2
7
3
4
6
1
2
5
production staff
and faculty

### shops & storage

1. Model and set shop
2. Central storage
3. Equipment receiving, storage and maintenance
4. Loading platform

### television production

1. Studios (a variety of sizes)
2. Studio control
3. Central engineering, control and distribution
4. Projection
5. Recording
6. Storage
7. External production slab

### supporting services

1. Graphic-arts studio
2. Animation
3. Still Photography
4. Film materials processing
5. Editing and assembly
6. Preview
7. Graphic and film materials storage
8. Offices, storage and toilets
9. Dressing and make-up

### film production

1. Film studio
2. Sound-film studios
3. Control and engineering
4. Storage
5. External production slab

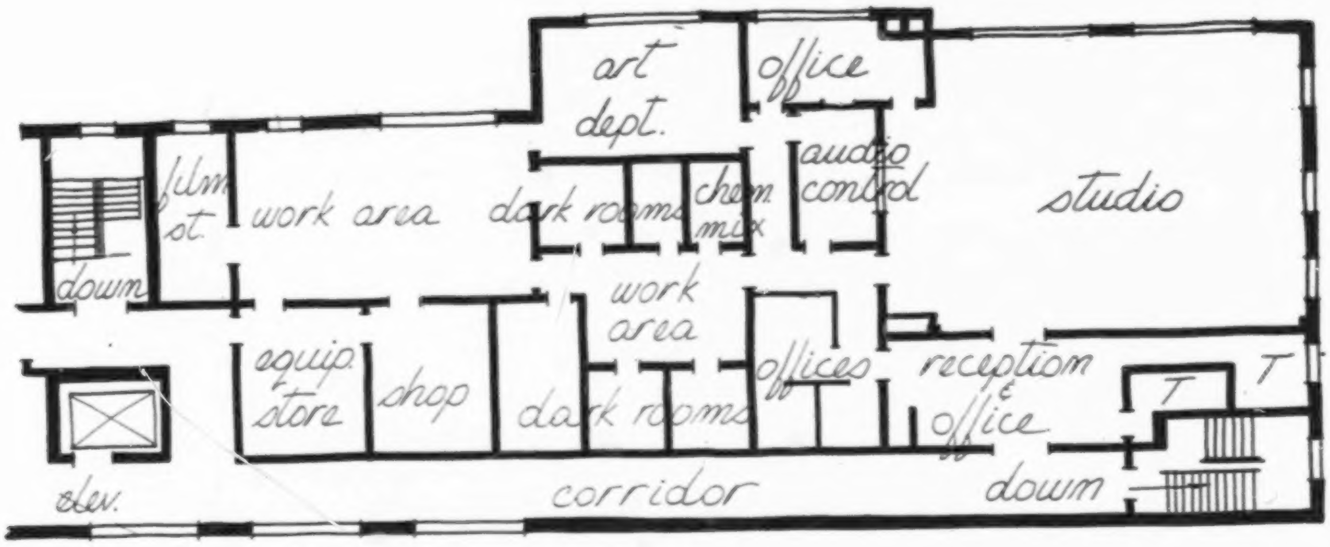
### administration

1. Reception and clerical
2. Film Vault
3. Production staff offices
4. Conference-rehearsal rooms
5. Sound-recording studios
6. TV faculty offices
7. Conference-reference rooms

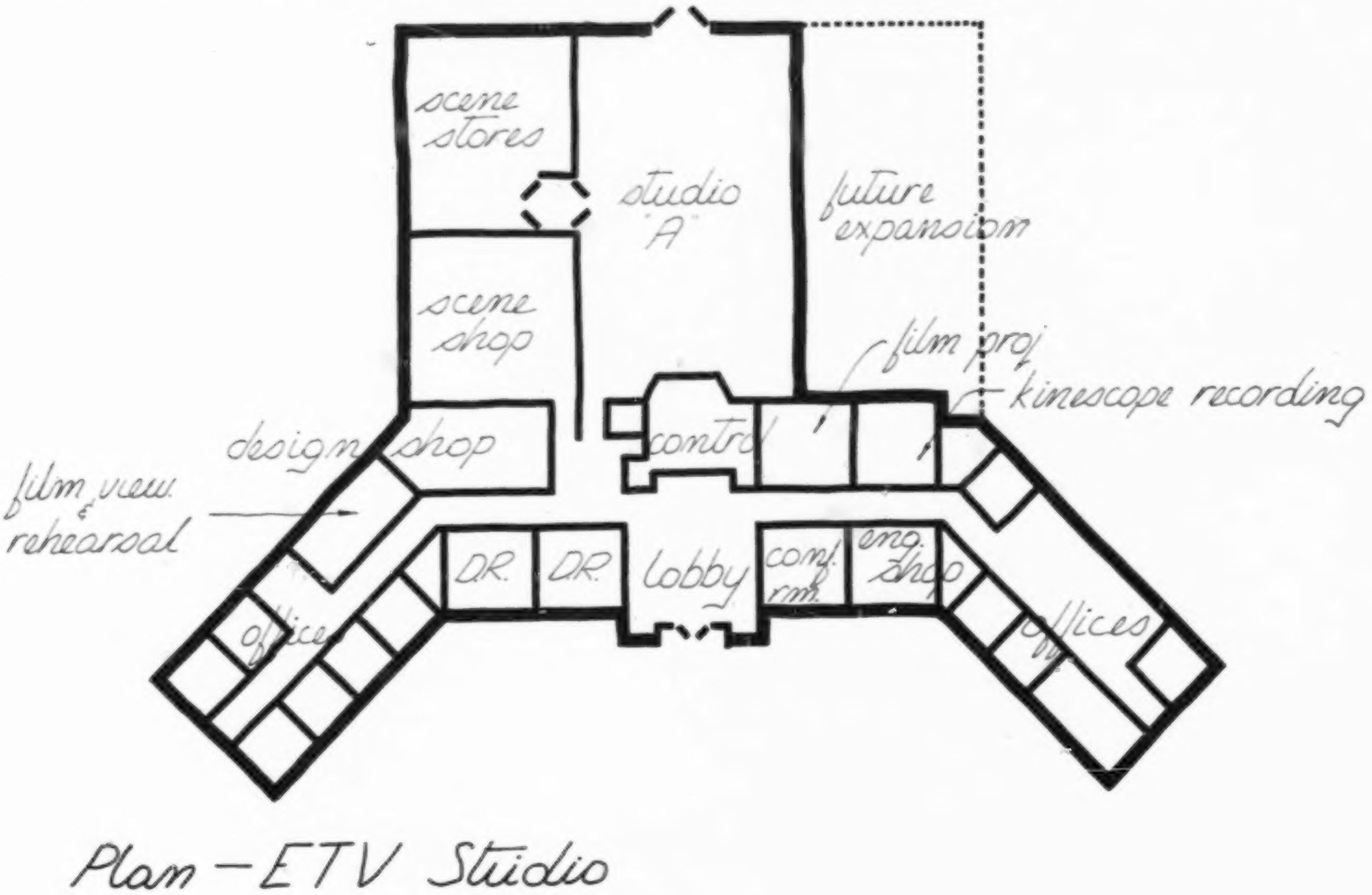
## 4. Examples of Existing Facilities

When discussing the design of a particular building type it is often beneficial to analyze examples of existing similar facilities in terms of spaces and relationships. This becomes particularly significant when the facilities are composed of a number of spaces and functions where the relationships between them may be critical.

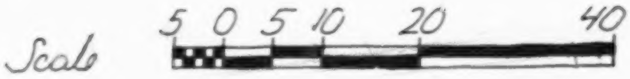
Although the following plans and descriptions of six production facilities are by no means intended to be comprehensive, they do indicate some of the spaces and relationships involved in such building types. They were chosen to show the wide range of approach to the production process taken by different institutions and persons.


art dept.
office
film st.
work area
dark rooms
chem mix
audio control
studio
down
work area
equip. store
shop
dark rooms
offices
reception & office
T
T
elev.
corridor
down

Plan - Audio Visual Service Scale: below


scene stores
studio "A"
future expansion
scene shop
film proj
kinescope recording
design shop
control
film view & rehearsal
D.R.
D.R.
lobby
conf. rm.
eng. shop
office
offices

Plan - ETV Studio


Scale
5
0
5
10
20
40

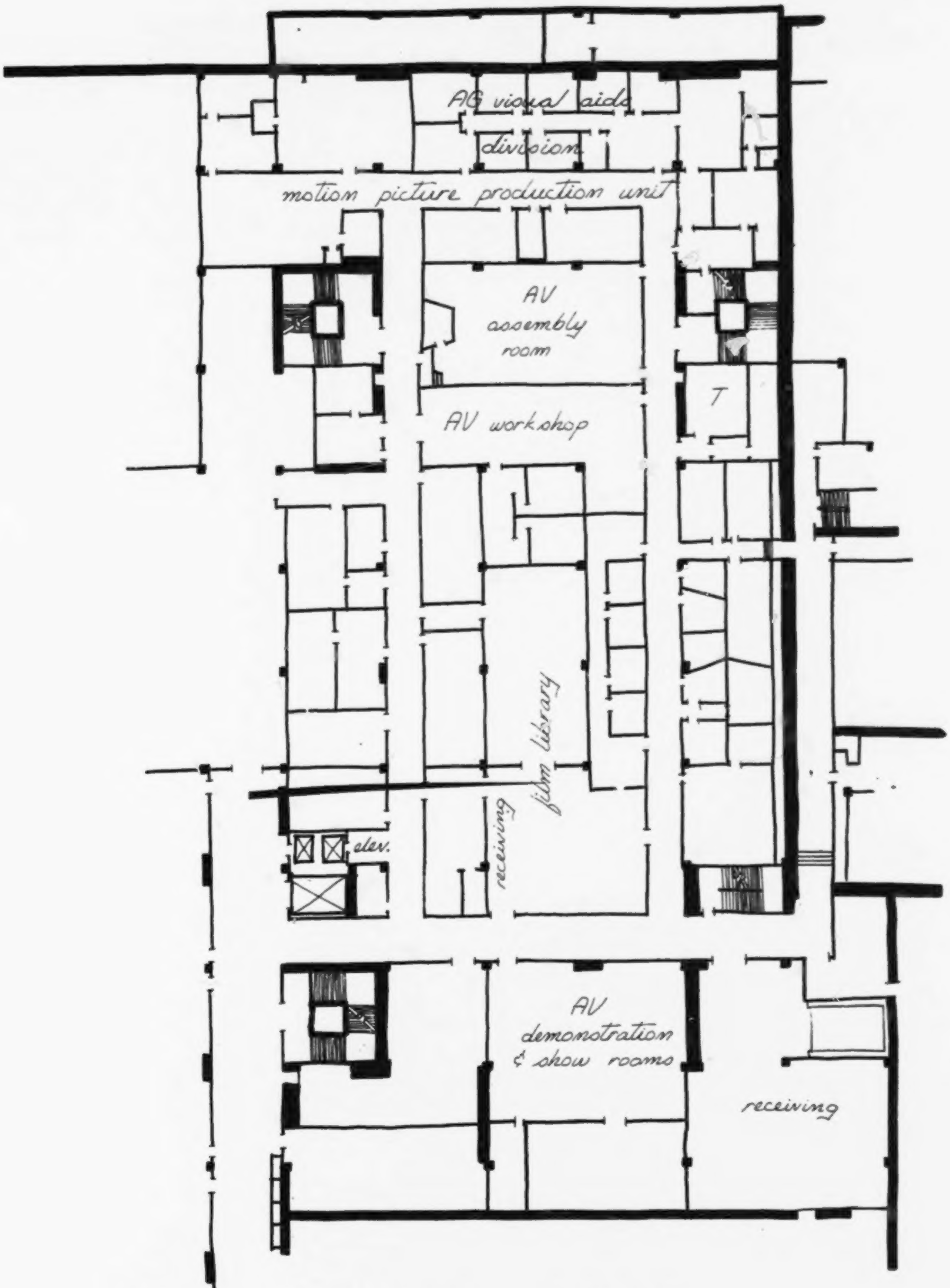
Miami University, Ohio
Audio Visual Service

As a means of helping instructors develop effective visual materials by bringing the "visualizer" and the "technician" together in one production area, Miami established its Audio Visual Service Department. The plan at the right shows the spaces and relationships involved in the facility which occupies part of one floor of Gaskill Hall. The development of "multi-media" materials means that the same visual may be made for use in front of the TV camera, as a slide for the overhead projector, or as a large illustration for direct classroom use. The facility functions as a service to the instructional faculty.

Station KETC, St. Louis
Baer Memorial Studio

This studio building houses educational television Station KETC which is a non-profit, community-supported facility serving Washington University, St. Louis University, and some fifty public and parochial school systems. The station, put into operation in March, 1955, operates at a power of 30,000 watts and covers a radius of approximately 50 miles containing a population of two million people. The building contains 15,000 square feet and is completely air-conditioned. Of particular interest is the provision for future expansion. (The Scene Shop can become another studio, with the Design Shop its control room.)

Designer: Jack Chenoweth
Chief Engineer of Station KETC


AG visual aids division
motion picture production unit
AV assembly room
T
AV workshop
film library
receiving
elev.
AV demonstration & show rooms
receiving

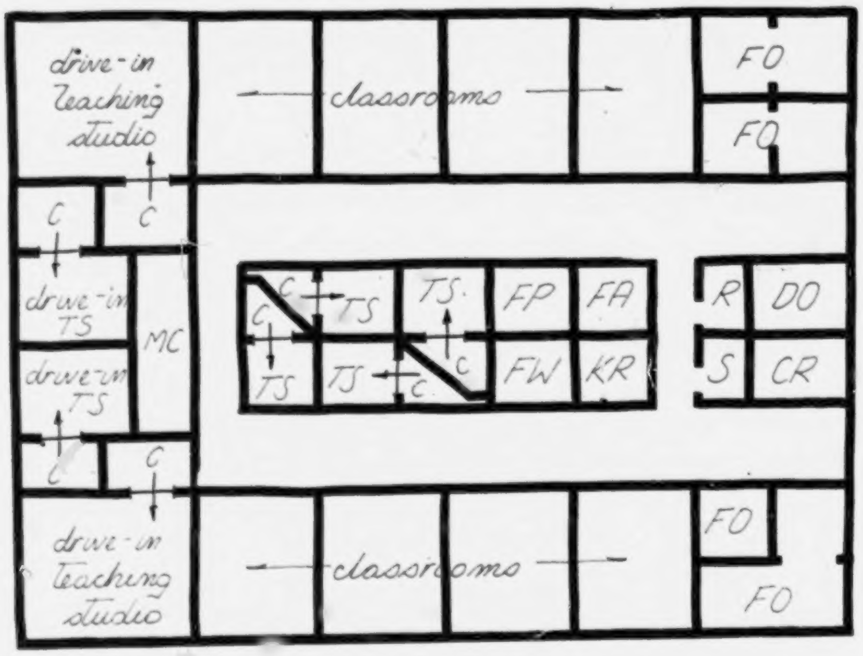
Plan of Audio-Visual Center

Scale: 10 0 10 20 40 80

Audio-Visual Center
Memorial Center Building
Purdue University

The Audio-Visual Center occupies most of the ground floor of the 8½ million dollar Memorial Center completed in 1958. It includes motion picture production, assembly and demonstration of audio-visual aids, two viewing rooms, a 100 seat lecture hall, film library, television viewing rooms, and booths where tapes, slides and films can be reviewed by individual students. A back-to-back arrangement of the viewing rooms permits one projectionist to operate equipment for both rooms from a single projection booth. On the floor below (basement) the Audio Visual Center provides construction of exhibits in a seven room shop area under the AV demonstration and show rooms.

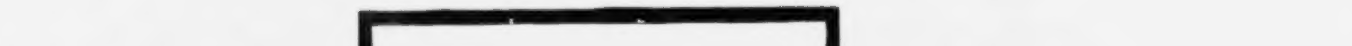
Architects: Walter Scholer and Associates
Lafayette, Indiana


drive-in teaching studio
classrooms
FO
FO
C
C
drive-in TS
MC
drive-in TS
C
C
C
TS
TS.
FP
FA
R
DO
C
TS
TS
C
FW
KR
S
CR
drive-in teaching studio
classrooms
FO
FO

FA - film audition
FO - faculty office
FP - film projection
DO - dean's office
CR - conference room
TS - teaching studio
KR - kinephoto recording
FW - film work room
MC - master control
C - control
R - reception
S - stenographer

Schematic Plan –
TV Teaching Center

Scale: 5 0 5 10 20 40



Suggested Concept of a TV Teaching Center
Reprinted from AERT Journal, (now the NAEB Journal), January 1957

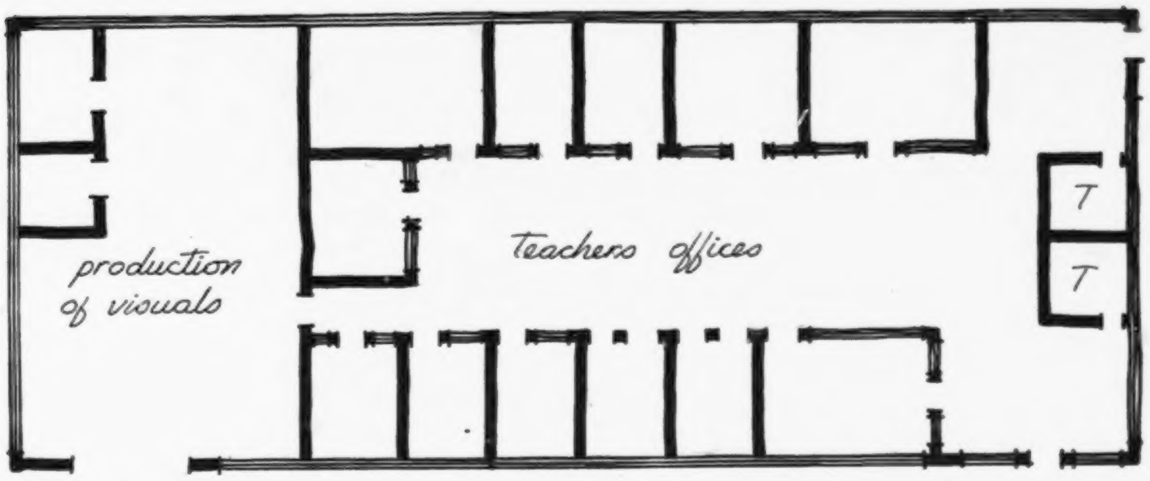
The drawing represents a scheme discussed by L. L. Lewis* in an article entitled "The TV Teaching Center" which pulls classrooms into the same building as the television production facilities. This probably has limited application in large installations where the production facilities become complex and where considerations of structure, circulation, and acoustics, would make the two functions incompatible in the same building. The drive-in studio concept is of interest, particularly in science and engineering curriculums.

*Educational Administrator, Electronic Products Dept., R.C.A., Camden, N. J.

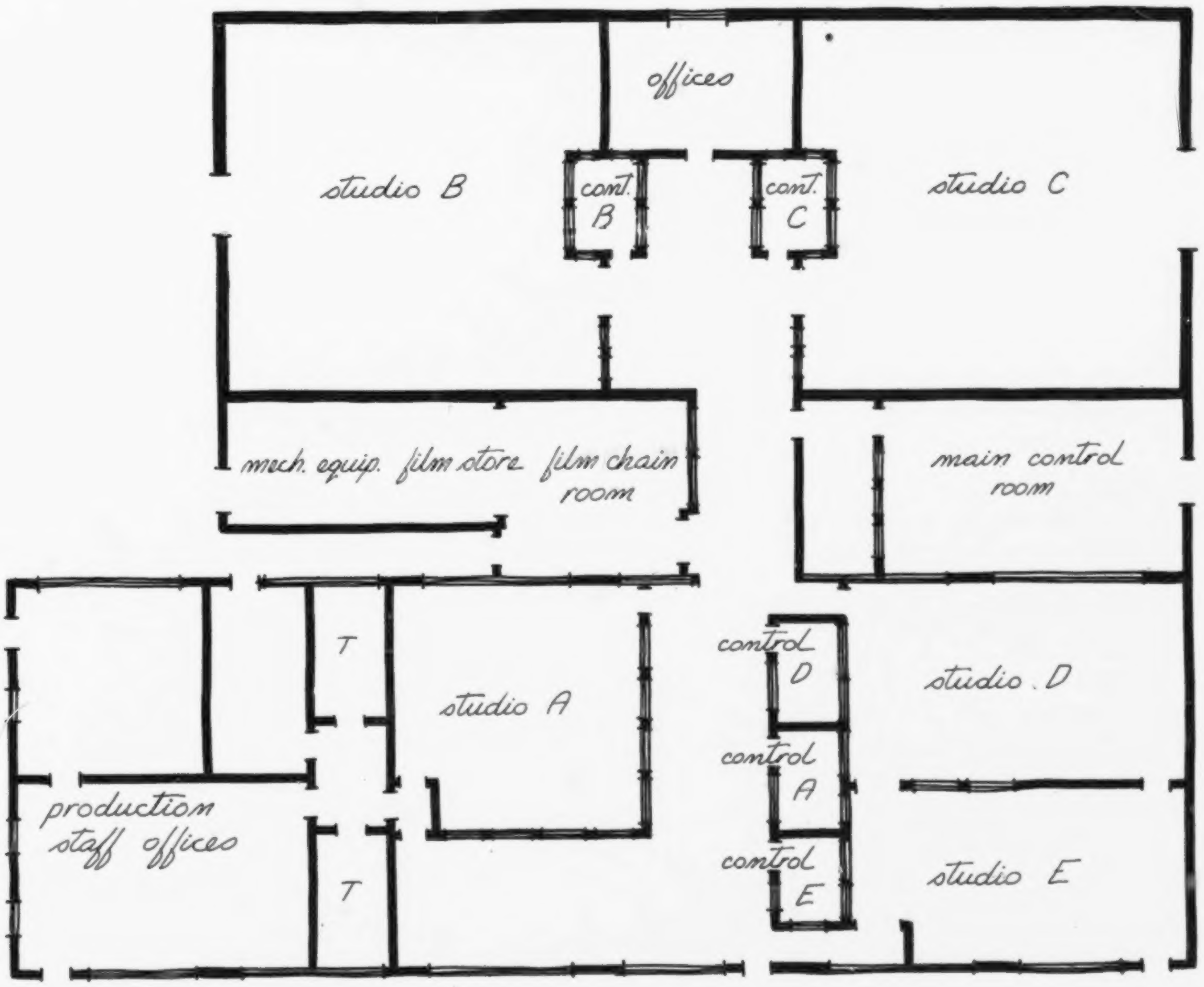
Television Center
St. Petersburg Junior College
St. Petersburg, Florida

This building houses the television production facilities that serve both a junior college and a public school system. Between the two studios, each with a floor area of 1200 sq. ft., is a two-story control-engineering center. Each of the studios is directly accessible to a large storage area on one side and production offices and work areas on the other. The very compact arrangement demands a minimum of circulation space.

Architect: C. Dale Dykema
St. Petersburg, Florida


production
of visuals
teachers offices
T
T

Plan — TV Faculty Offices


offices
studio B
cont.
B
cont.
C
studio C
mech. equip.
film store
film chain
room
main control
room
T
studio A
control
D
studio D
control
A
production
staff offices
control
E
studio E
T

Plan — Studio Building

Scale :
5
0
5
10
20

Studio Building
Washington County School System
Hagerstown, Maryland

When the Washington County schools began their televised instruction experiment, it was necessary to provide adequate studio space. Centralized studios serving the entire county were converted from existing school maintenance buildings in Hagerstown. All televised instruction originates from five studios, each with its own control room. The faculty offices are actually located to the left of the studio building, which permits easy direct contact between the TV teachers and the production staff. The graphics shop, where visuals are produced for use in the studios, is located adjacent to the offices so the faculty members can again work directly with the production personnel. The whole production operation takes place in an informal, yet seemingly efficient, atmosphere.

# FACTORS IN DESIGN

## D. Instructional Materials Access Center

As a result of the increasing use of the aids and media and with the resultant loss sometimes of face-to-face contact, it becomes important to provide ready access by the students to the instructional materials used in class. Just as a student has a textbook, laboratory manual or syllabus for review as well as initial instruction, so the films, tapes, and other instructional materials should be made available for similar functions. Access to these materials enables:

1. Absent students to cover material he missed.
2. All students to review points on which they need clarification and to prepare for examinations.
3. Students not taking the course to use the materials for additional reference and individual study and exploration.

It is the potential of such a facility that leads to the discussion of an "Instructional Materials Access Center".

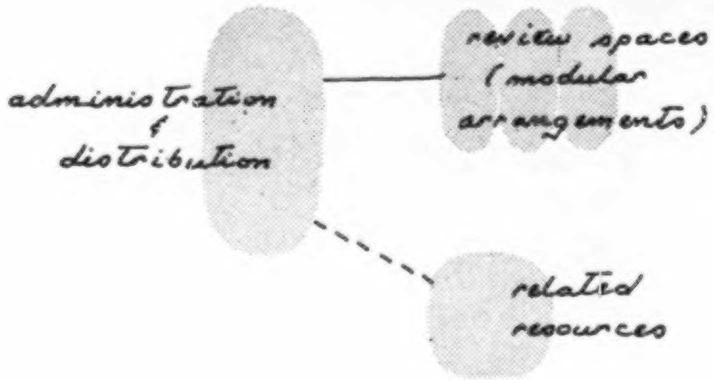
The Center supports a library-type function; the collecting, editing, cataloguing, distributing and retrieving of film and tape materials. The distribution process is the chief concern and includes both the handing of materials to students and the electronic distribution of materials by television and audio networks. In either case, the students will usually review the materials in spaces within the Center designed for that particular function.

To meet the requirements of varying needs, the review spaces should range from individual review booths to small and medium size group rooms. It is possible that some materials may be reviewed in dormitories, study halls, and other points on the campus by utilizing closed-circuit television originating from the Access Center or possibly from the Television Production Unit. Because of this latter consideration, there may be a close functional relationship between the Access Center and any television production units.

An Access Center serving one school in a large university complex, may be the logical location for additional instructional resources. Such resources could include electronic computers for student use, a technical publications library, a suite of counseling rooms for student-faculty conferences, and additional electronic random-access information retrieval devices. These resources would be programmed and oriented to fill the needs of the particular curriculum.

The Access Center may well be part of a resource complex including the book library and its related functions. Also in time, all resource materials whether printed, film or tape materials, electronic devices, or whatever may be grouped together administratively as well as physically.

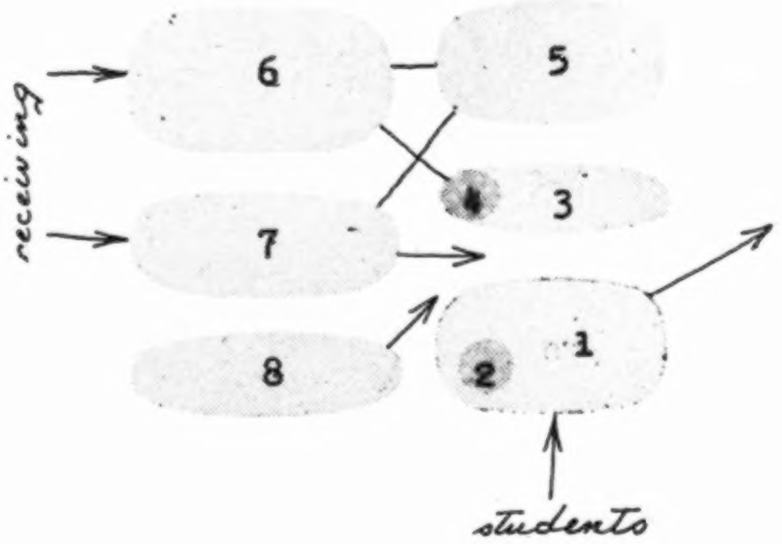
The Access Center may then consist of either two or three components:


administration
&
distribution
review spaces
(modular
arrangements)
related
resources

The spaces and functions within the components may be:

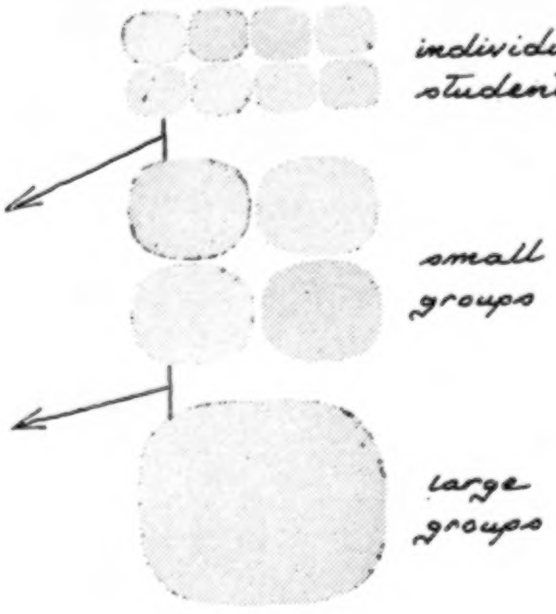
## administration and distribution

1. Entry, lobby and circulation space.
2. Card file - file system (may be electronic) of all materials available for student use.
3. Control desk - staffed by personnel that check materials out to students, assign review spaces, schedule materials to be distributed by closed-circuit, and coordinate group reviewing.
4. Ready storage - materials for which a high demand is anticipated.



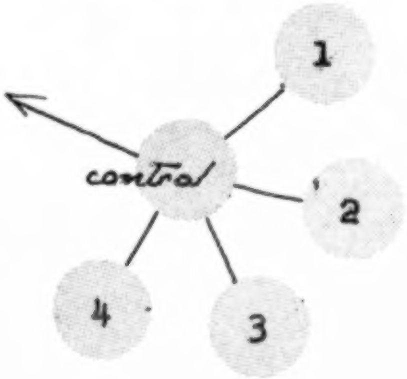
5. Central Engineering, control and electronic distribution - contains slide and film chains and video-tape playback equipment for distributing materials via closed-circuit television to the review spaces in the Center or to other review spaces throughout the campus. Also contains audio tape distribution equipment and equipment for receiving and distributing of signals from the Television Production Unit (which may include "off-the-air" television). Random access information storage and retrieval equipment may be located here and tied into the distribution system for the Center.
6. Film and tape materials receiving and storage - materials waiting for use by students in the review spaces or distribution from central engineering.
7. Equipment receiving, storage and maintenance.
8. Offices, conference rooms and toilets.

## review spaces



Study-review spaces - the spaces in which the student actually sees and hears the film and tape materials by either using individual projectors and play-back equipment or by receiving the material from Central Engineering. To handle the variety of size groups and review needs, it is necessary to provide spaces each with varying capacities and equipment. Therefore, spaces are provided for individual students, small groups (4 to 6) and larger groups (20 to 40). To achieve further flexibility in group size, a number of different spaces can receive the same material distributed from Central Engineering. Some of the spaces may contain "teaching machines" in one form or another.

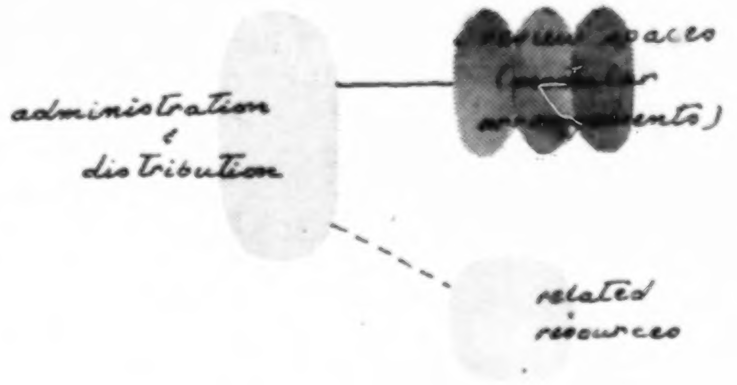
## related resources



Additional learning sources that may be housed in the Instructional Materials Access Center and which were discussed previously:

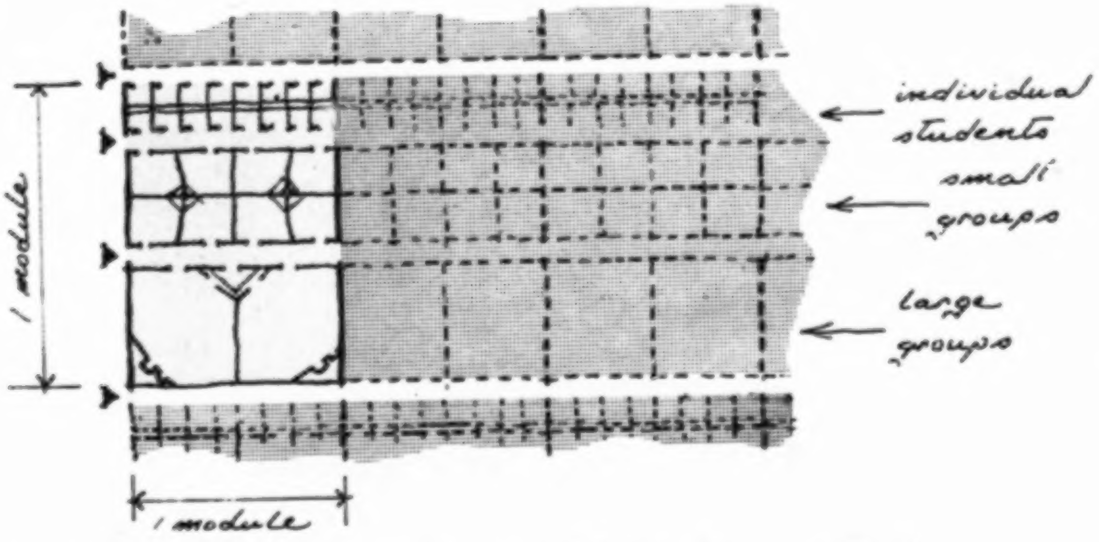
1. Electronic computers.
2. Technical publications library.
3. Counseling suite.
4. Information storage and retrieval.

# INSTRUCTIONAL MATERIALS ACCESS CENTER
## Architectural Considerations


administration & distribution
review spaces (modular arrangements)
related resources

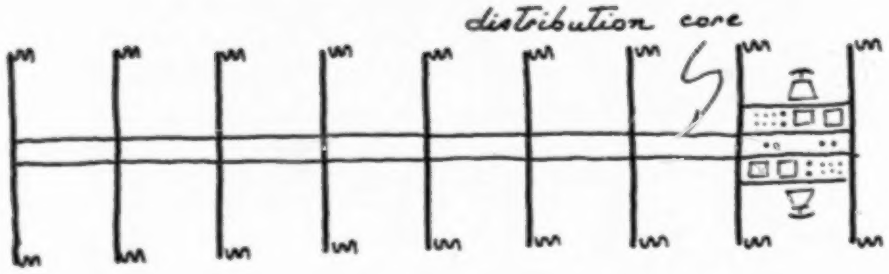
Admittedly the architectural design considerations for a facility such as the Instructural Materials Access Center are based in a large part on the highly specialized equipment that it will house - equipment much of which is not completely developed or readily available at the present time. As the need for facilities such as the Access Center becomes more widely recognized and the equipment requirements are spelled out, the electronics industry may well respond with systems of equipment to fulfill the distribution-review functions.

A concept for the review spaces is developed in this report and is based on a module approach. This is discussed and illustrated in the following drawings.


1 module
1 module
individual students
small groups
large groups

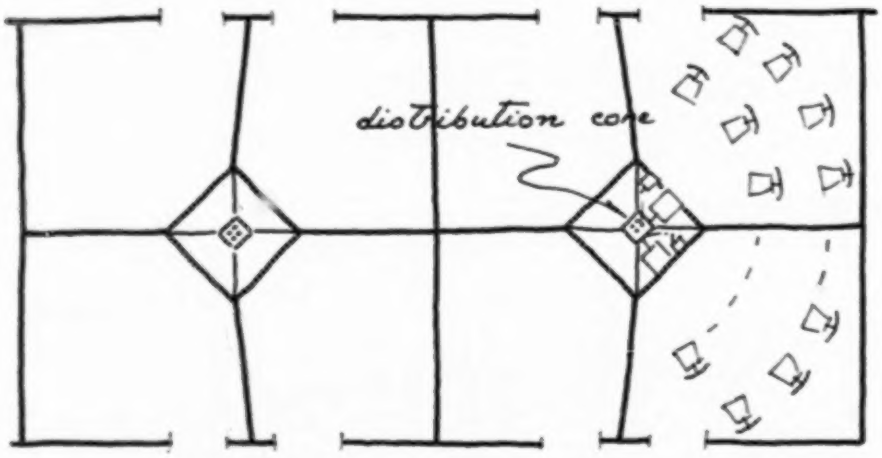
The basic module may be repeated (either vertically or horizontally) to achieve the desired number of "review stations."

## basic module for review spaces


distribution core

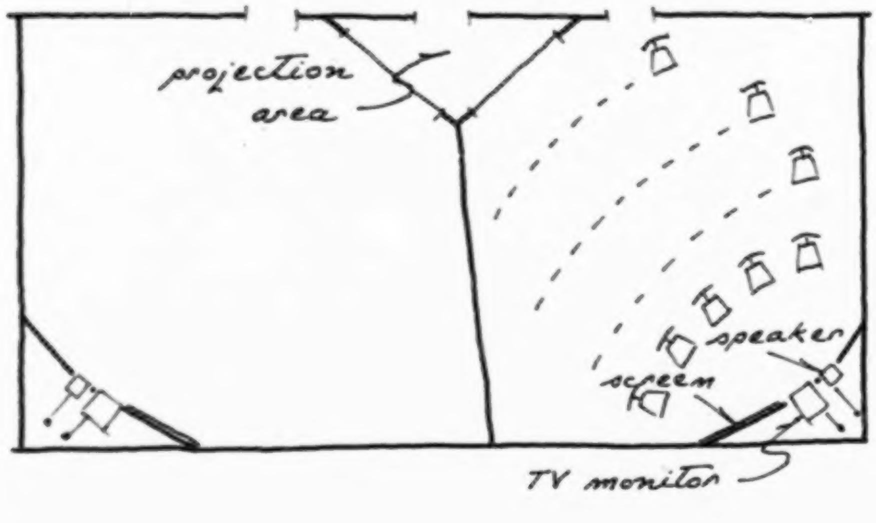
**individual spaces**
- . capacity — 1 student

equipment:
- . individual TV viewer
- . cartridge loaded viewers for slides & films
- . head-phone audio reception


distribution core

**small group spaces**
- . capacity — 6 to 8

equipment:
- . small TV monitor
- . cartridge loaded viewers for slides & films
- . audio tapes distributed from central engineering over audio net.


projection area
speaker
screen
TV monitor

**large group spaces**
- . capacity — 16 to 20

equipment:
- . TV monitor
- . audio tapes distributed from central engineering over audio net
- . films & slides projected from projection area

# PART III

# DESIGN STUDIES

## LEARNING SPACES

. . . . a series of drawings with accompanying text illustrating the design criteria discussed in the report, and representing a range of capacities and functions . . . .

# PART III

## DESIGN STUDIES

The design studies that follow are presented as possible solutions for a rather wide range of situations. All have one general concept in common: the spaces are designed to support and enhance a teaching-learning process which includes, to a greater or lesser degree, the use of instructional aids and media.

The studies are not plans ready for direct application to a particular building program but are intended, together with the accompanying text, to serve as "guidelines". For any individual institution, the design of such facilities must be based on the educational philosophies and curricula of that institution, and must grow out of a clear statement of educational requirements and needs. These considerations are basic to architectural programming.

All of the designs presented reflect certain principles evolving from the thesis that "optimum use of instructional aids and media requires new concepts of space types and their design". While many of these principles will become apparent on examination of the drawings, a brief statement of the more important ones is given below to summarize the conclusions resulting from this study:

1. An optimum viewing area, as defined by the various images to be viewed, will determine the most effective room shape. The optimum area is not a fixed function of the screen or monitor size, but will vary with the type of material being viewed, the duration of the presentation, the quality of the equipment, and factors of environment.

2. Stepped or sloped floors will provide the best viewing conditions in all rooms; in the smaller rooms they may not be feasible. In the large rooms sloped floors are essential for good sight-lines; steep gradients in spaces designed for lecture-demonstrations do not appear justified as they are wasteful of space and reduce the effectiveness of the space for other functions. Magnification of critical aspects of a demonstration can be accomplished by projection techniques or television. In the smaller spaces, the desire for possible rearrangements of the seating may render stepped floors objectionable.

3. The actual capacity of a space, as defined by a viewing area, is a function of the seating type and arrangement, and applicable building codes. Adequate writing surfaces and stepped floors tend to imply fixed seats and continuous tables for the larger spaces. Building codes usually limit to 14 the length of a row of seats, although wider row spacing (continental seating) will permit longer rows. Center aisles are to be avoided, as they occupy the best viewing area. In the smaller spaces a seminar arrangement of seats as opposed to a focused arrangment, will probably reduce the capacity.

4. Windows in the learning spaces, whether the spaces be large or small, are a liability rather than an asset. Two of the major functions of windows are to introduce daylight and provide visual contact with the out-of-doors. Both detract from the most effective use of aids and media.

5. All learning spaces should be air-conditioned. With the absence of windows, mechanical ventilation becomes a necessity. Cooling will generally be required, even in cold weather, not only to remove the heat generated by occupants and equipment, but also to provide a stimulating environment.

6. Proper acoustic treatment in all rooms, and sound isolation between rooms is essential. These involve no unique problems as far as treatment of surfaces and use of materials are concerned, but several important details require particular attention. A means must be employed to isolate the noise of all projection equipment, and careful attention must be paid to preventing sound transmission through ductwork systems. In addition, a single high-quality, carefully designed sound system should be provided for distributing the audio element of any of the aids and media.

7. Carefully planned, special lighting is a prime essential to the proper functioning of these spaces. Lighting levels for both the writing and surrounding surfaces should be carefully related to image brightnesses, and variable intensities appropriate to each instructional device should be provided. In addition, ample illimination for conventional lecture and discussion purposes is necessary. All controls should be preset and coordinated with the devices, and located for ready operation by the instructor in charge.

8. From initial stages of design the mechanical, structural, acoustical and lighting elements must be considered together as coordinated systems. Design of one system without regard for the others may seriously impair their later accommodation. For instance, location of mechanical ductwork in a ceiling, without regard for the location of the lighting, may result in the lighting fixtures being placed in less than desirable locations.

9. A conscious effort toward carefully designed color schemes in the rooms, and between rooms is desirable. Color, as a function of lighting, is critical in these rooms as there are no windows for visual relief and because lighting and surface reflectance has to be carefully planned for optimum viewing. In addition, as students move from room to room, the color schemes should change to provide a variation, and thus avoid monotony of environments.

10. In designing the spaces, aids and media should be considered with instructional methods as integrated systems, rather than simply pieces of equipment to be included in the spaces. As an example, a projector and its required screen are not independent items to be accommodated, but are closely related and inter-dependent component parts of an instructional system.

11. The concept of a coordinated "display surface" or "teaching wall" should be encouraged. The aim of this concept is to integrate and coordinate as far as possible all instructional materials within an appropriate area, rather than to provide a collection of separate and distinctly defined exhibits.

12. Whenever feasible, projection equipment should be centrally located in a "projection center" or "area" and should be remotely controlled by the instructor. (The possible exceptions are the overhead, opaque, and shadow projectors.) In this way, the instructor remains at the front of the room, continuously in control of the presentation. Such an arrangement also permits technicians to ready equipment during a class period.

13. There are no overriding advantages of either front or rear projection to the exclusion of the other. Particularly in the larger spaces, either one may be appropriate depending on the functions of the space, personal preferences, and the nature and amount of space provided. Some of the disadvantages of either may be overcome by indirect projection (using mirrors).

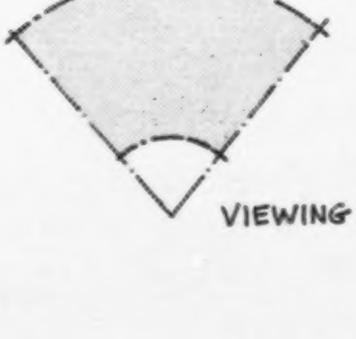
14. Particularly in larger spaces, there are definite advantages to a single, large, projected television image over a number of small monitor images scattered about the spaces. At the present time, economic and functional limitations of the equipment will not always permit realization of this goal, and instead a number of monitors will be provided. In the smaller spaces, where no more than 2 or 3 monitors are required for adequate viewing, projected television may not be practicable.

15. The adjunct service spaces which support the functioning of a learning space require careful consideration. These include preparation and storage areas. As a rule, they become more extensive, and their planning more critical, as the learning spaces become larger and support more functions.

16. Flexibility, a term with multiple meanings and implications for design, should be carefully analyzed and evaluated for each situation. Flexibility of functions within a space may be achieved by designing for the use of a variety of instructional aids and media. In the large spaces flexibility of function may be increased by use of multiple platforms, either slide-on or rotating. Flexibility between spaces by use of "flexible partitions" is possible, but not always feasible. By providing a variety of spaces representing a range of capacities and functions, flexibility may be achieved by scheduling of the spaces.

## SYMBOLS

| | |
|---|---|
| —·—·— | VIEWING DISTANCE LIMIT |
| —·—·— | VIEWING ANGLE LIMIT |
| ░ | VIEWING AREA 2W-6W |
| ▒ | VIEWING AREA 6W -7W |
| ▨ | PROJECTION AREA |
| ▓ | STORAGE AREA |
| ☰ | SCHEME LABEL |



VIEWING AREA PATTERN

Design Studies

SCHEME A

Design Studies

## DESIGN ANALYSIS - SCHEME A

This scheme, which has sometimes been referred to as the Auditorium-Studio scheme, incorporates many of the features necessary in large spaces to increase their utilization and in turn to render them economically feasible. Subsequent schemes B, C, D, and E, indicate alternate ways of achieving some degree of flexibility of use.

The drawings show the use of a two-part rotating stage 36 feet in diameter with a rear projection area above the back half of the stage. While one class is in session, demonstration apparatus or any needed equipment can be set up on the rear half of the stage, and during the class break the stage is rotated to put the set-up in the position for the next class.

Due to the rear projection area, any apparatus set up on the rear half of the stage is limited to about 7½ feet in height. However, in cases where heights of over 7½ feet are needed, the apparatus can be set up on "modular carts" in either of the two side preparation and storage areas, and can be wheeled directly on the front half of the stage during the class break. If desired, the curtain can be drawn across the front of the stage and a lecture can be held in the auditorium while the stage is being set up. In fact, the height limitation imposed by the rear projection area is the significant drawback to this scheme. Subsequent schemes show the use of front projection which alleviates this particular problem.

The two preparation areas permit extensive use of demonstration apparatus both on the stages and in the television studio. In addition, a storage balcony is provided in each preparation area. Back of the stage is a "modular cart" storage area. Here carts either preset with equipment or designed for multiple demonstration set-ups, are stored awaiting use on the stage. A shop for receiving and maintenance of equipment is located with direct access to an external service area.

In addition to the supporting areas mentioned above, this scheme includes a television studio with engineering-control, camera storage, and office areas. The studio provides one more degree of flexible use of the facility. Demonstrations too large and cumbersome to be taken on to the stage can be televised from the studio and received in the auditorium. An external production slab adjacent to the studio and an overhead crane further facilitate this function. With preparation, storage, and modular cart areas nearby, the studio has a wide variety of materials at hand for televised production serving other instructional areas on the campus in addition to the auditorium. The studio would also permit "off-the-air" and remote origination to be piped into the auditorium.

Three twelve-foot wide screens are arranged across the front of the viewing area and above the stage. These allow the showing of up to three images simultaneously from the rear-projection area. The throw distance required by some projection equipment may require indirect projection using mirrors. Below the screens are blackboard areas and control panels for lighting, projection equipment, utilities and apparatus, as well as jacks for television cameras and controls.

The functions normally handled by the overhead projector (enlarging writing, etc.) may be handled in this scheme by closed circuit television with cameras focused on the instructor's writing surfaces and the enlarged image seen by projected television. This same system can be used for magnification of critical demonstration sequences. An overhead-projector could be used, but it would require an auxiliary reflective screen, and a system of mirrors to prevent keystoning of the image.

As an alternate to projected TV in this scheme, a number of monitors could be suspended from the ceiling or raised from the floor in the auditorium area. The single projected TV image has a number of advantages, among which are the instructional advantages of a single image towards which all students focus their attention, and the fact that monitors scattered about the space are difficult to position without interfering with sight lines of other display surfaces.

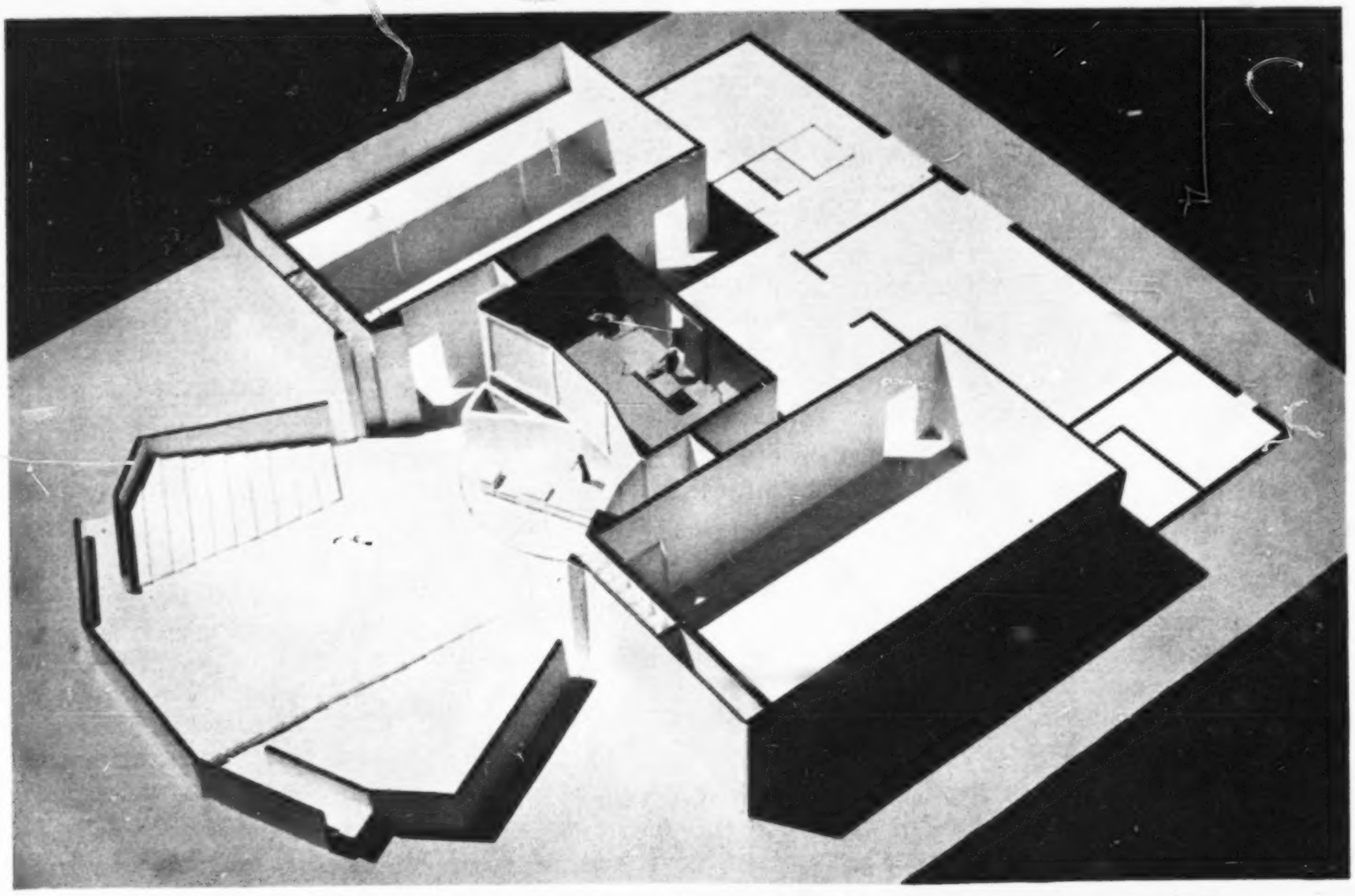
To permit the auditorium area to have the dual function of a television studio, an originating booth is located at the rear of the seating area. From there the lecture and/or demonstration can either be recorded for future reference and use, or televised to other areas on the campus. Close-up shots are handled by remote cameras above the stage or cameras mounted on a modular cart.

It will be noted that the two outside rear projection screens are canted at angles of 10 degrees to the center screen. This is done to improve the shape of the optimum viewing area which is defined by 40 degrees side angles from the planes of the screens. The outline of the optimum viewing area is indicated; the boundary of the front row of seats is determined by a line located at twice the width of a single image (2W) from the screen surfaces. The definition of the rear of the viewing area is based on both 6W and 7W, and each of these boundaries is also shown. Within a 6W boundary, the capacity of this scheme is approximately 325 students; and using the 7W boundary the capacity becomes 450 students.

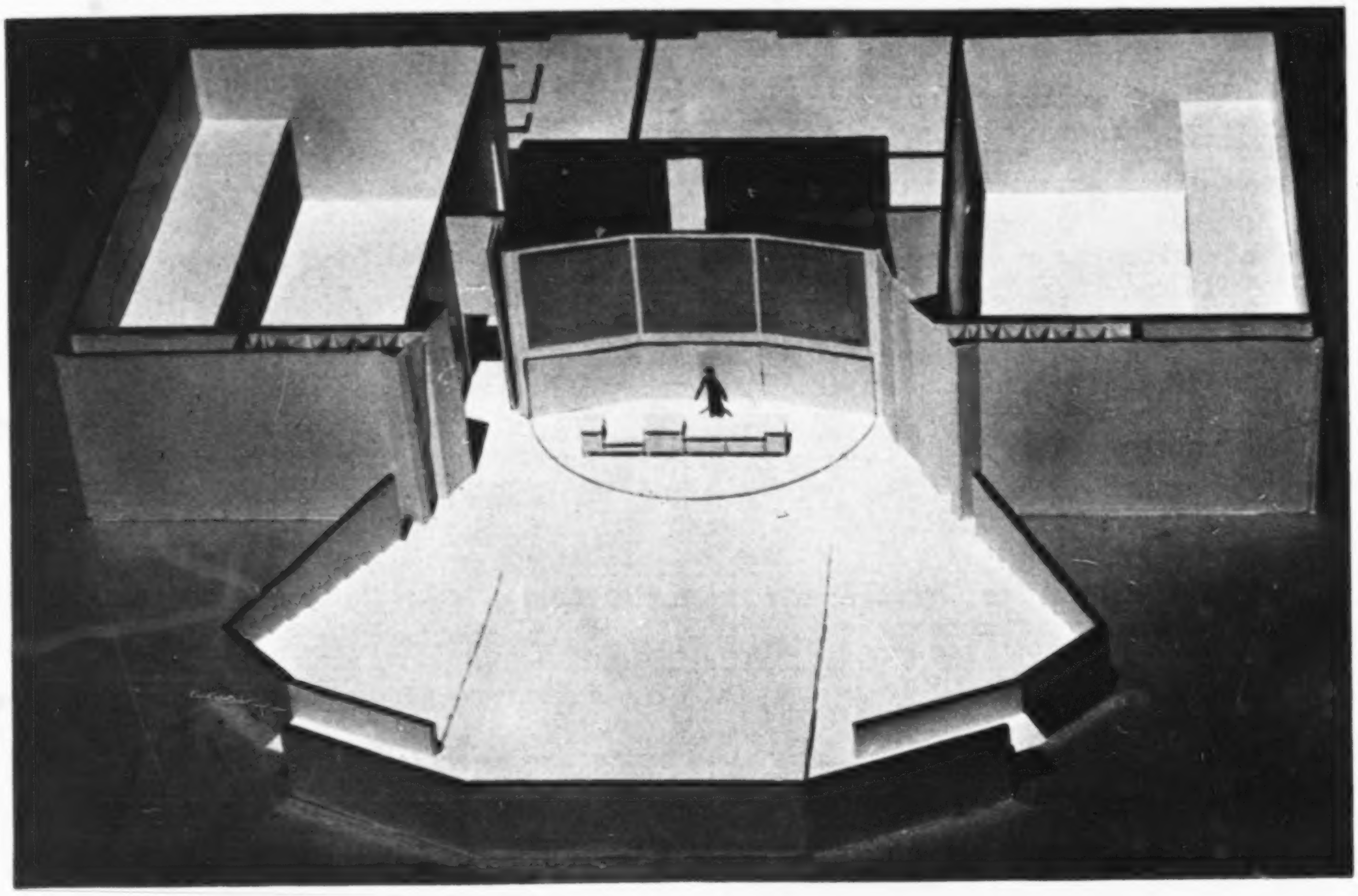
The actual arrangement of seats is based on a maximum 14 seat row, which requires two intermediate side aisles. If continental seating is used, the two side aisles will occur against the walls and occupy space otherwise occupied by the least desirable seats. To permit all students in the auditorium to see demonstrations being presented on the stage, the floor of the auditorium is sloped. The section drawing A-A shows the profile of the stepped flooring, and the planes of the ceilings.

For acoustical considerations, a sloped "sounding board" is located over the stage, and the hard, reflective plastered ceiling is a flat surface sloping from the high point to approximately 10 feet above the rear row. The rear walls and part of the side walls of the auditorium will be surfaced with sound absorptive materials to control reverberation within the space. Downlights, illuminating a student's writing surface, will be used throughout the auditorium area, in addition to general lighting on the walls and ceiling. Auxiliary spotlighting for demonstrations and display surfaces on the stage areas, will be housed in the overlap of the two planes of the ceiling.

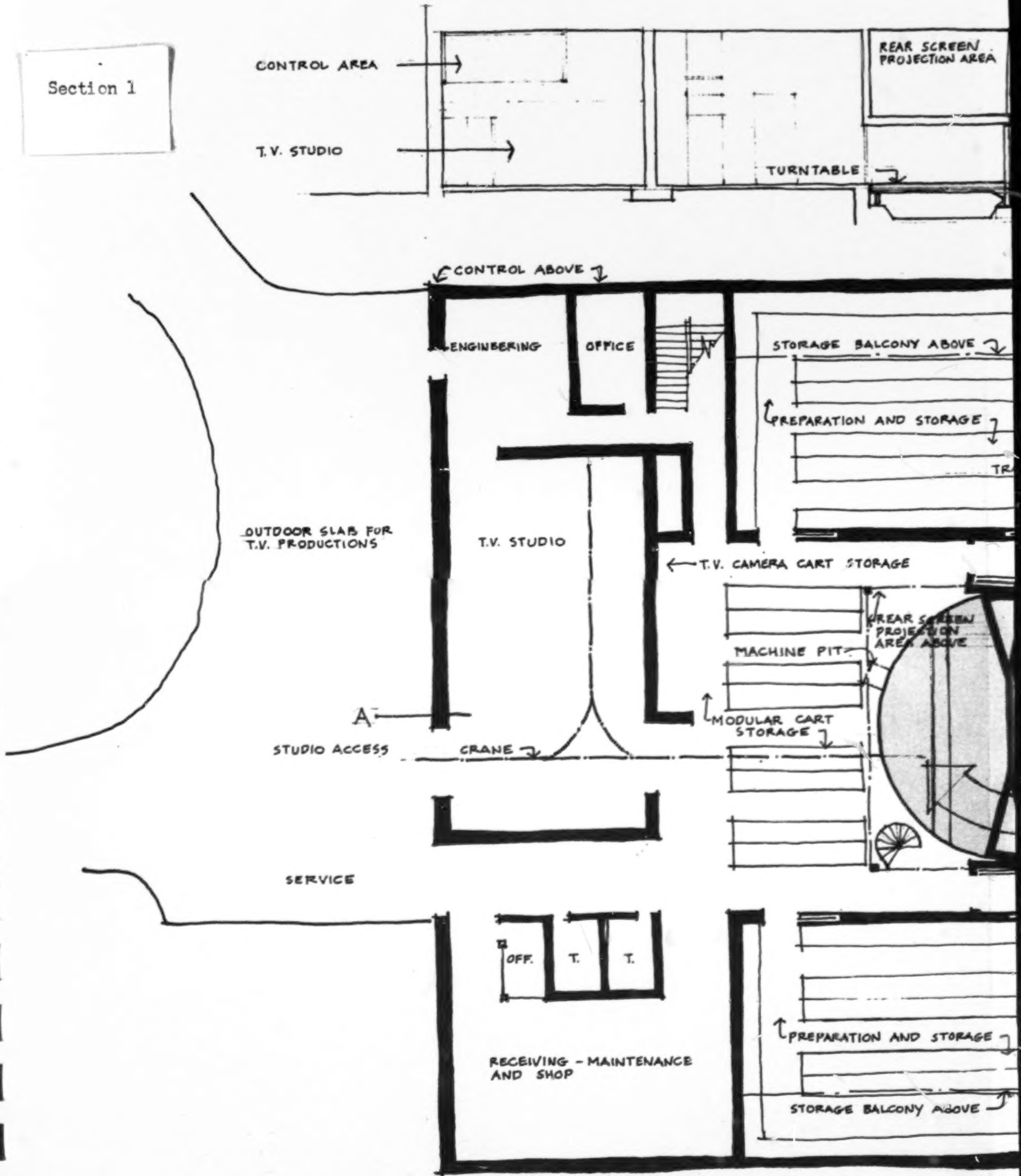
This Scheme A indicates what might be considered near maximum flexibility of use for an instructional space of this size. It should permit an extremely high rate of utilization.



As part of the development of Scheme A, a cut-away model was built to further illustrate the size and relationship of the spaces involved. These photographs of the model serve as further explanation of the scheme.

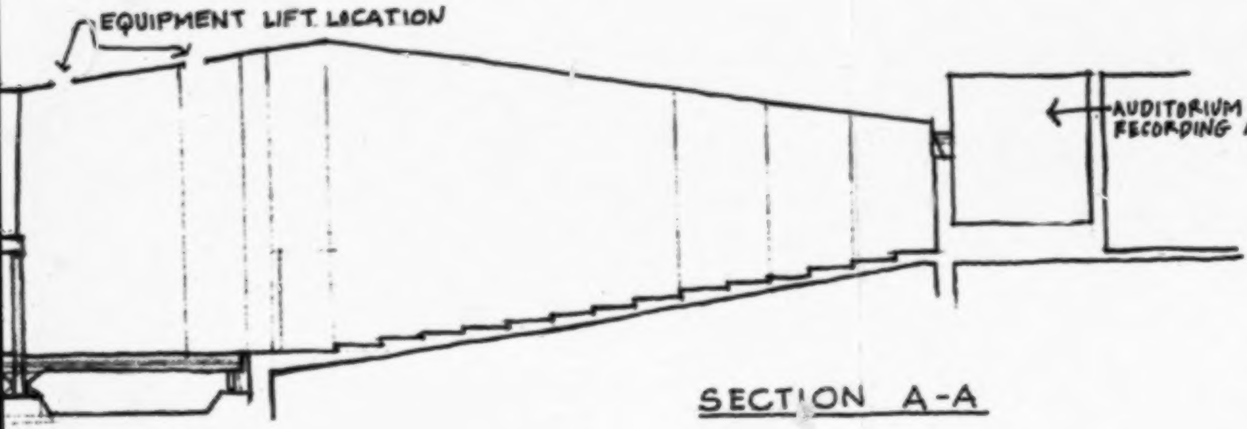


Section 1

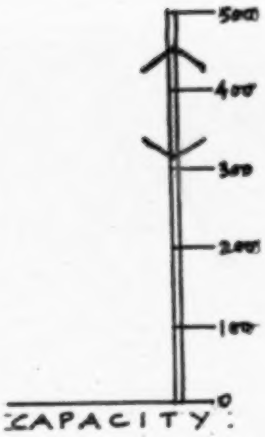

CONTROL AREA
T.V. STUDIO
REAR SCREEN PROJECTION AREA
TURNTABLE
CONTROL ABOVE
ENGINEERING
OFFICE
STORAGE BALCONY ABOVE
PREPARATION AND STORAGE
TR
OUTDOOR SLAB FOR T.V. PRODUCTIONS
T.V. STUDIO
T.V. CAMERA CART STORAGE
REAR SCREEN PROJECTION AREA ABOVE
MACHINE PIT
MODULAR CART STORAGE
A
STUDIO ACCESS
CRANE
SERVICE
OFF.
T.
T.
RECEIVING - MAINTENANCE AND SHOP
PREPARATION AND STORAGE
STORAGE BALCONY ABOVE

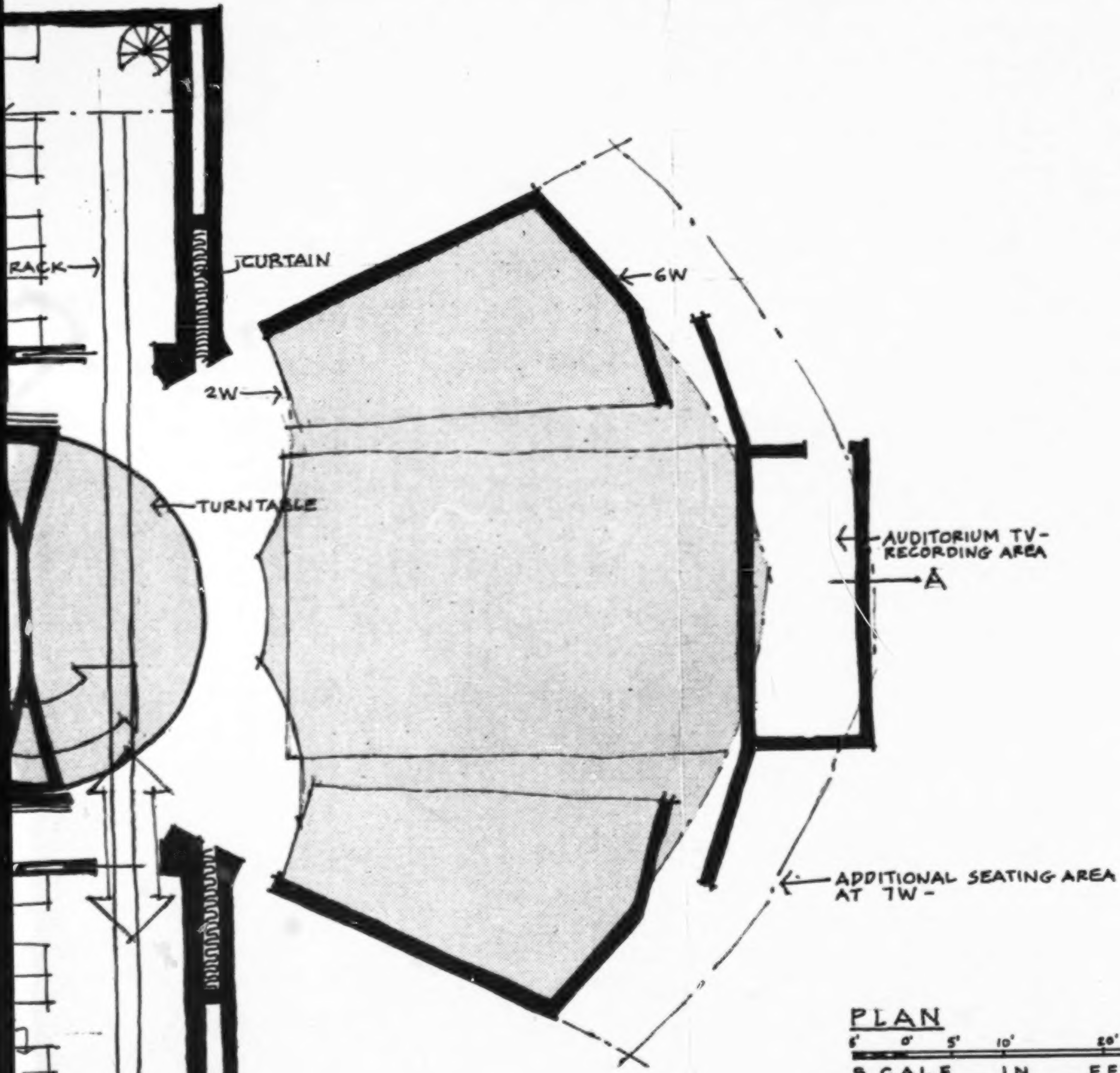
F

A


EQUIPMENT LIFT LOCATION
AUDITORIUM RECORDING AREA

SECTION A-A



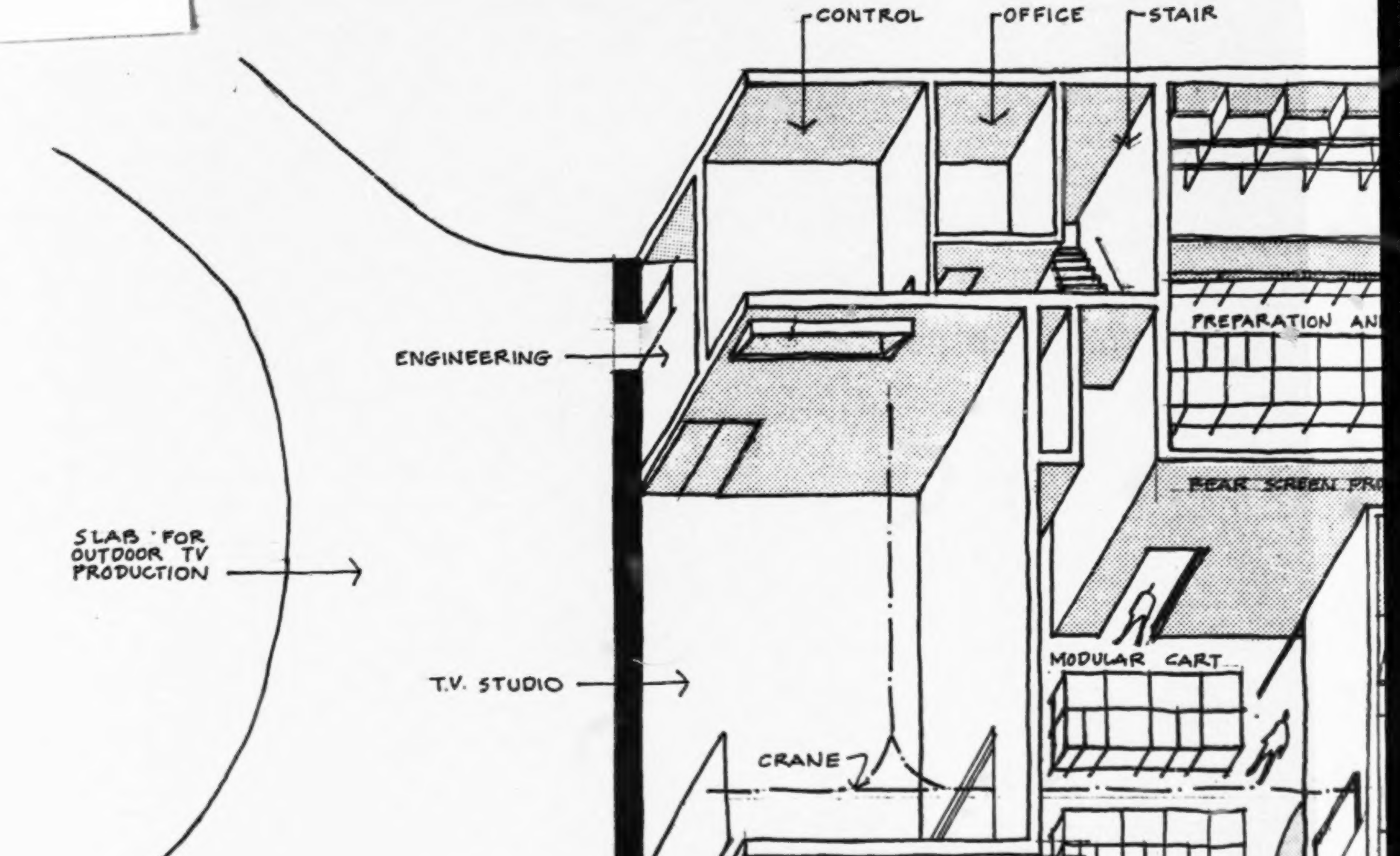

RACK
CURTAIN
6W
2W
TURNTABLE
AUDITORIUM TV-RECORDING AREA
A
ADDITIONAL SEATING AREA AT 7W -
5'
0'
5'
10'
20'
30
SCALE IN FEET

PLAN

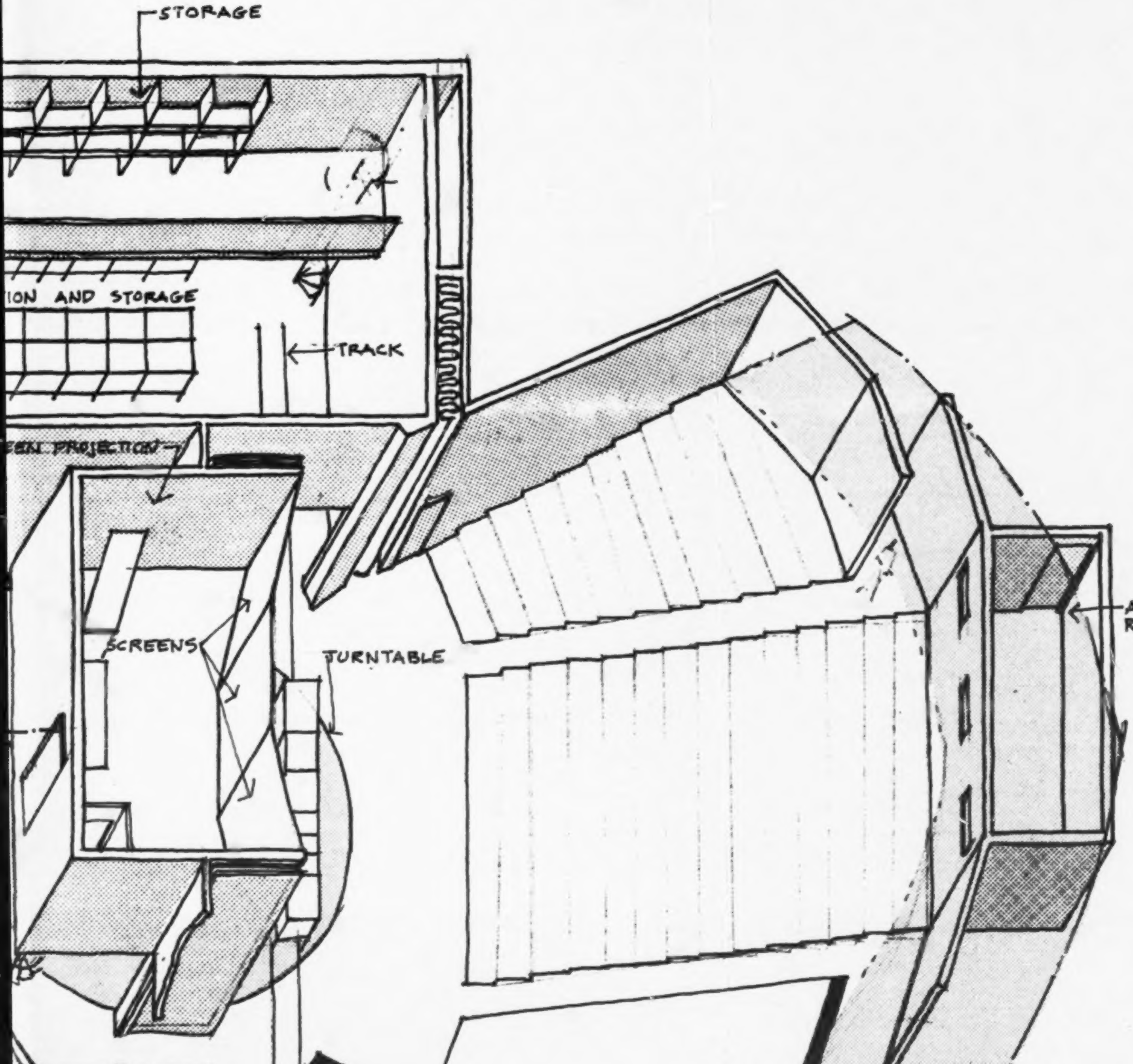
* FOR ALTERNATE AUDITORIUM SEATING DIAGRAMS SEE SCHEME "B"

Section 2

Section 1


CONTROL
OFFICE
STAIR
PREPARATION AN
ENGINEERING
REAR SCREEN PR
SLAB FOR OUTDOOR TV PRODUCTION
MODULAR CART
T.V. STUDIO
CRANE
STORAGE
PREPARATION AND
OFFICE
RECEIVING MAINTENANCE AND SHOP

F


STORAGE
ION AND STORAGE
TRACK
EEN PROJECTION
SCREENS
TURNTABLE
AUDITORIUM T.V. RECORDING AREA
ADDITIONAL SEATING AREA AT 7W.
ON AND STORAGE

Section 2

Design Studies

SCHEME B

Design Studies

## DESIGN ANALYSIS - SCHEME B

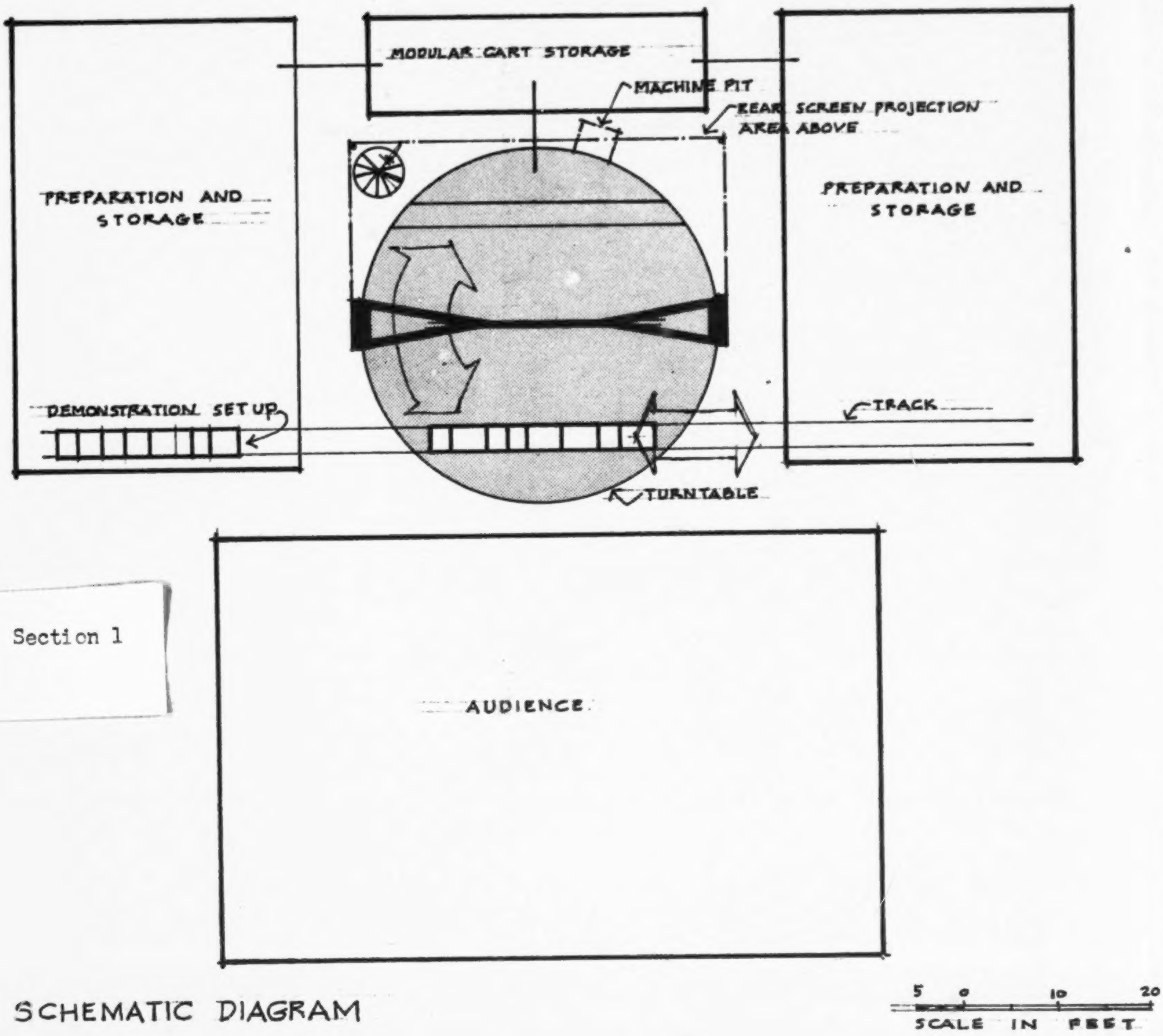
These drawings indicate a more analytical approach to a two-part rotating stage scheme. The drawing in the upper left hand corner shows a definition of the turntable, with related areas of audience, preparation and storage, and modular cart storage. This is shown to indicate the basic relationships between these areas and the turntable.

The three drawings in the upper right-hand corner indicate the variety of audience arrangements that might be possible with this two-part stage scheme. The three arrangements are based on three different approaches for defining the angles and minimum and maximum distances for a viewing area. The first is based on 40 degree edge angles, the second on 30 degree edge angles, and the last on 60 degree total center angle. In addition the light gray area indicates the extent of a 6W seating area, and the darker gray indicates the increased extent of a 7W seating area. By employing such approaches to the design of the audience area, capacities for such a scheme may vary from 250 to 600 students.

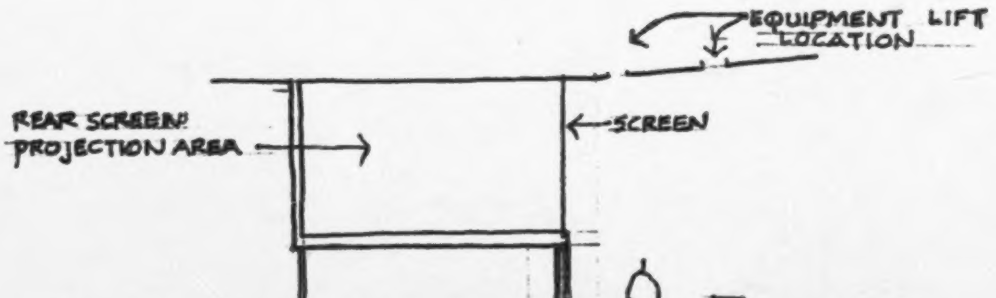
The isometric drawing shows the turntable stage in relationship to a rear-projection area. As noted in the discussion of Scheme A, it is likely that some of the equipment housed in the rear-projection area will utilize mirrors to bend the projection beam when the distance required for their direct projection is not available. The rear-projection area is a fixed area above the stage which rotates beneath it.

The section drawing indicates the relative heights and relationships involved in the rear-projection and stage areas. It will be noted that equipment lifts are provided above the stage area to enable demonstration apparatus to be hung from the ceiling. In addition, the stage is shown to be level with the floor in the front of the auditorium. This in a sense permits the entire front of the auditorium to become a stage whenever necessary, and particularly when it is to be used for functions other than instructional uses. Access to the rear-projection area is by a stairway; an overhead crane is provided for bringing in equipment.

Section 1


MODULAR CART STORAGE
MACHINE PIT
REAR SCREEN PROJECTION AREA ABOVE
PREPARATION AND STORAGE
PREPARATION AND STORAGE
DEMONSTRATION SET UP
TRACK
TURNTABLE
AUDIENCE
5 0 10 20
SCALE IN FEET

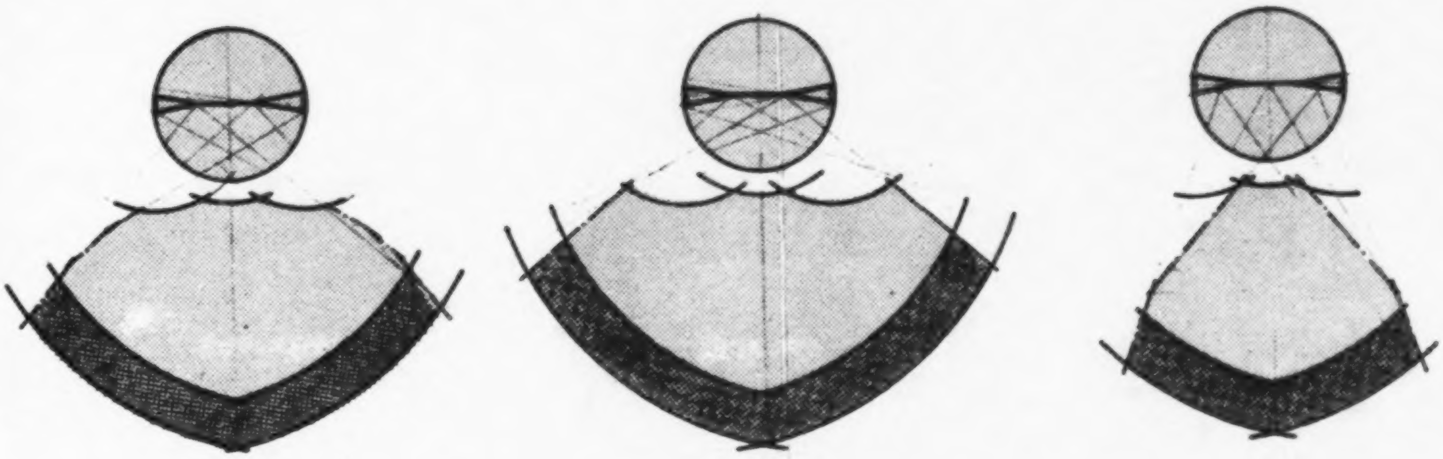
SCHEMATIC DIAGRAM


EQUIPMENT LIFT LOCATION
REAR SCREEN PROJECTION AREA
SCREEN
TURNTABLE

TYPICAL SECTION

F

B

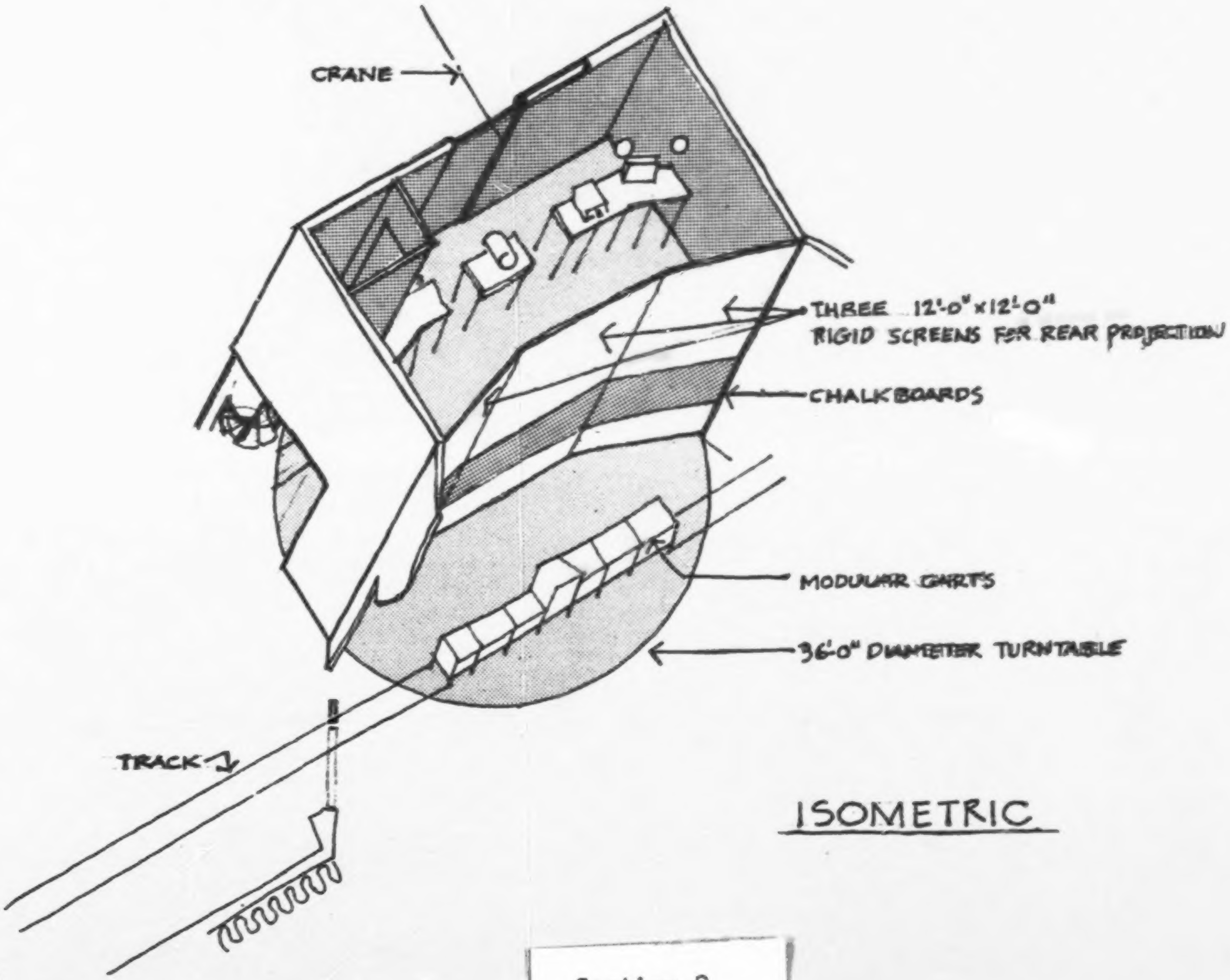


40° EDGE ANGLE
CAPACITY
2W-6W 325
2W-7W 450

30° EDGE ANGLE
CAPACITY
2W-6W 380
2W-7W 570

60° CENTERLINE
CAPACITY
2W-6W 215
2W-7W 325

## AUDIENCE ARRANGEMENT


CRANE
THREE 12'-0"×12'-0" RIGID SCREENS FOR REAR PROJECTION
CHALKBOARDS
MODULAR CARTS
36'-0" DIAMETER TURNTABLE
TRACK

ISOMETRIC

Section 2

## Design Studies

## SCHEME C

## DESIGN ANALYSIS - SCHEME C

These drawings indicate the considerations for a two-part turn-table stage combined with front-projection of film materials instead of rear-projection as shown in Scheme A.

Because there is no height limitation imposed by a rear-projection booth, demonstration set-ups up to 20 feet high, can be brought onto the rear half of the stage from the side preparation and storage areas. The demonstration equipment may be prepared on a series of "modular carts" which are fastened together in the desired order, and moved onto the stage as a unit. Any utilities that will be required can be connected and tested, and then during the class-break the stage is rotated, putting the demonstration set-up in position for the next class.

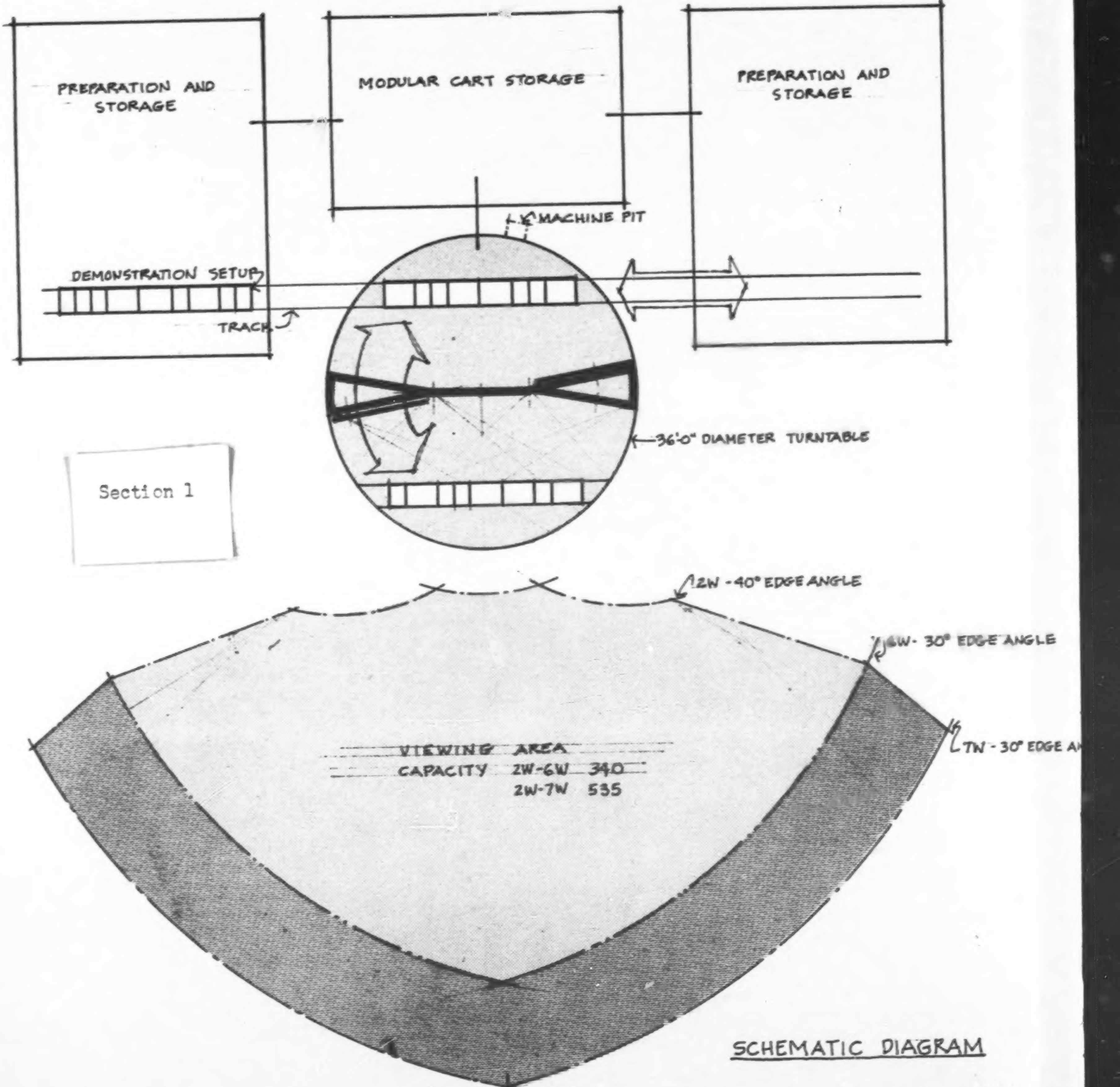
Three 12 by 12 foot reflective screens are provided across the middle of the stage for front-projected materials. The projectors, with the exception of the overhead and shadow projectors, are located in the projection area at the rear of the seating area. One of the screens, for use with the overhead projector, is designed to be tilted to avoid keystoning of the image. This arrangement of screens permits up to three images to be shown simultaneously if desired. The two outer screens are canted 10 degrees to the plane of the center screen to increase the viewing capacity.

The viewing area, shown by two shades of grey, would probably be considered the maximum desirable for this arrangement. The light grey, based on a minimum distance of two times the width of a single image (2W) and maximum distance of six times the image width (6W) has a capacity of 340 students. If the maximum distance is increased to 7W the capacity is increased to 535. If critical materials are to be shown on all screens, the side angles should be increased resulting in a reduced capacity.

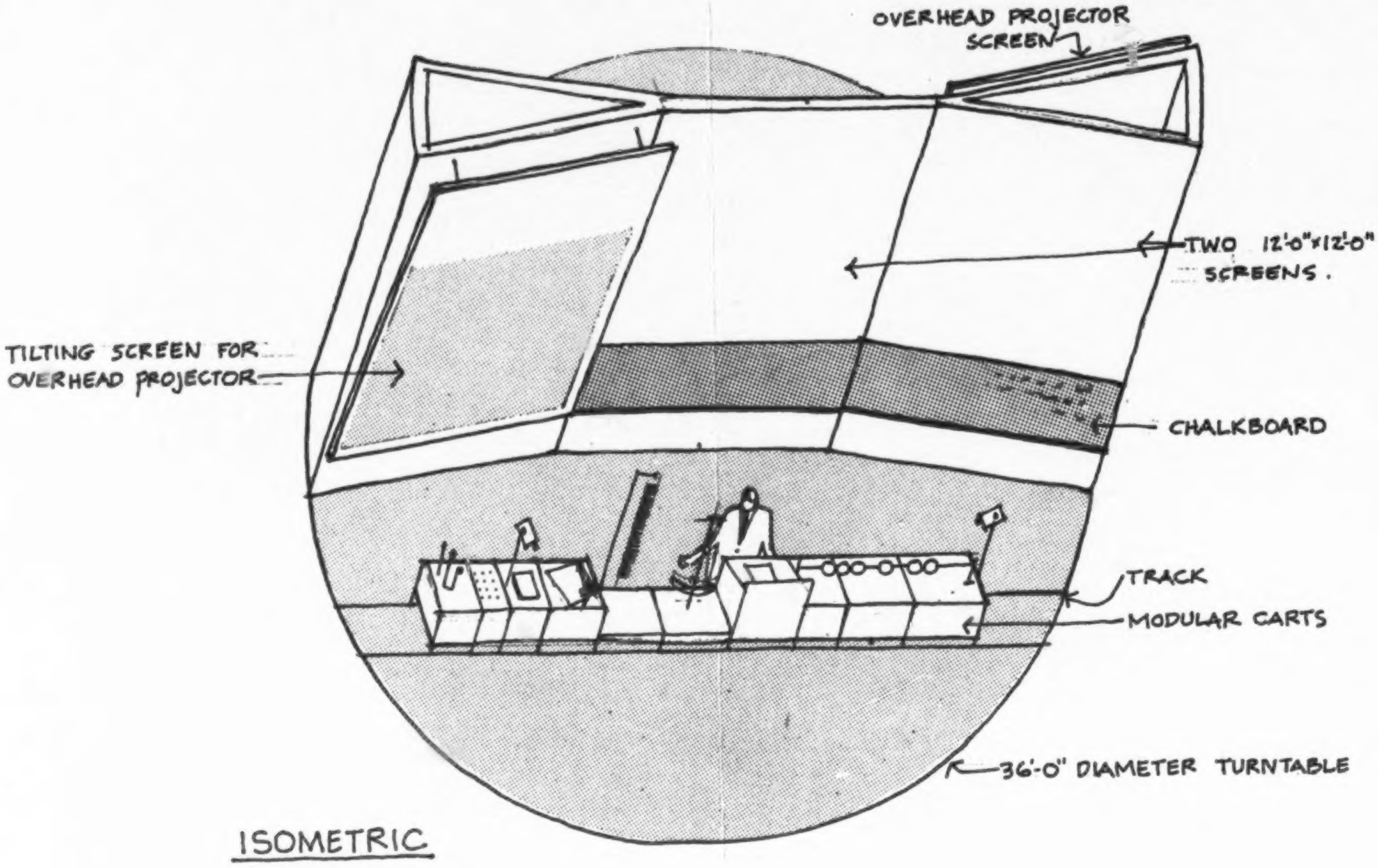
Television reception in this scheme could be handled by projected television or with monitors. In the former case, the barrel of the projector would probably be suspended over the viewing area; in the latter case monitors might be located as shown in the lower right diagrams.

This scheme would also have application to smaller spaces where multiple demonstration set-ups were to be employed.

Section 1


PREPARATION AND STORAGE
MODULAR CART STORAGE
PREPARATION AND STORAGE
MACHINE PIT
DEMONSTRATION SETUP
TRACK
36'-0" DIAMETER TURNTABLE
2W - 40° EDGE ANGLE
6W - 30° EDGE ANGLE
7W - 30° EDGE A
VIEWING AREA
CAPACITY 2W-6W 340
2W-7W 535
PROJECTION AREA

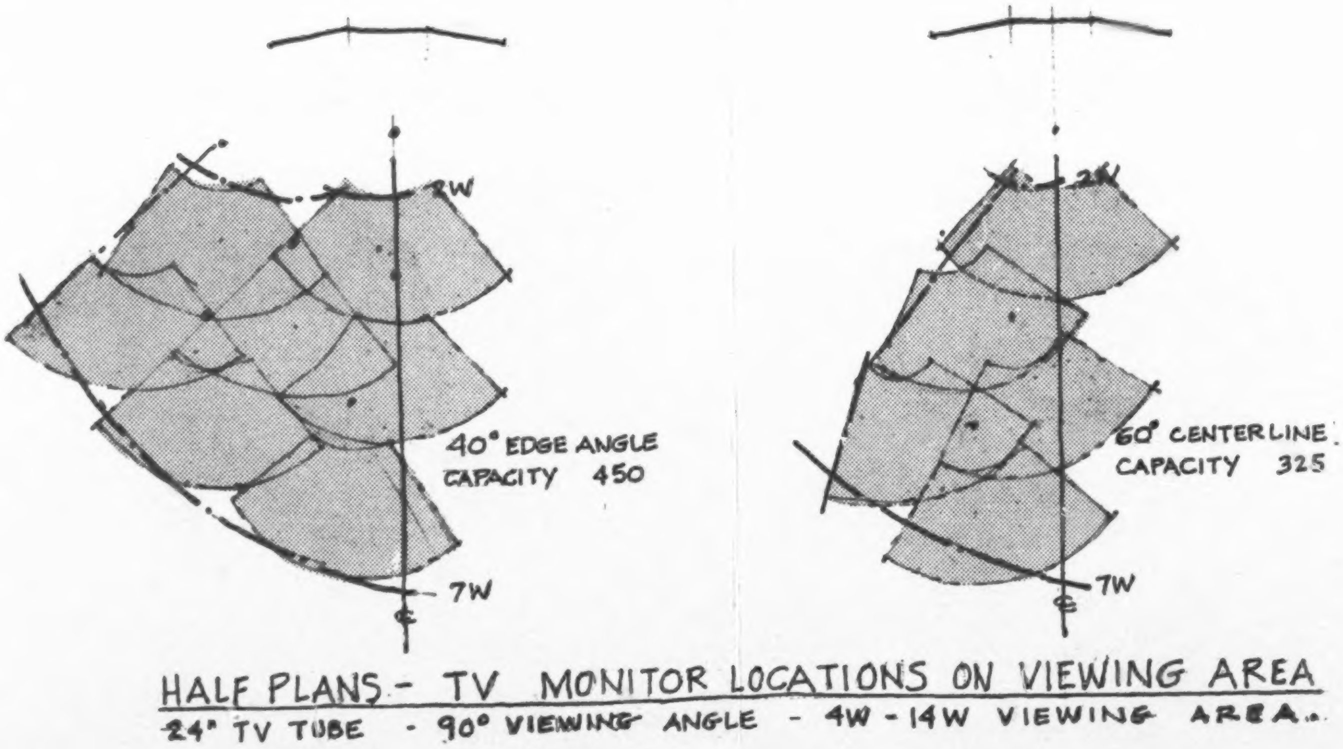
SCHEMATIC DIAGRAM


OVERHEAD PROJECTOR SCREEN
TWO 12'-0"×12'-0" SCREENS.
TILTING SCREEN FOR OVERHEAD PROJECTOR
CHALKBOARD
TRACK
MODULAR CARTS
36'-0" DIAMETER TURNTABLE

ISOMETRIC

NGLE

° EDGE ANGLE


2W
40° EDGE ANGLE
CAPACITY 450
7W
2W
60° CENTERLINE
CAPACITY 325
7W

HALF PLANS - TV MONITOR LOCATIONS ON VIEWING AREA

24" TV TUBE - 90° VIEWING ANGLE - 4W - 14W VIEWING AREA.

Section 2

**Design Studies**

**SCHEME D**

Design Studies

## DESIGN ANALYSIS - SCHEME D

These drawings indicate the considerations which affect the design of a large, instructional space where a three-part rotating stage is used to increase the flexibility and utilization rate of the space.

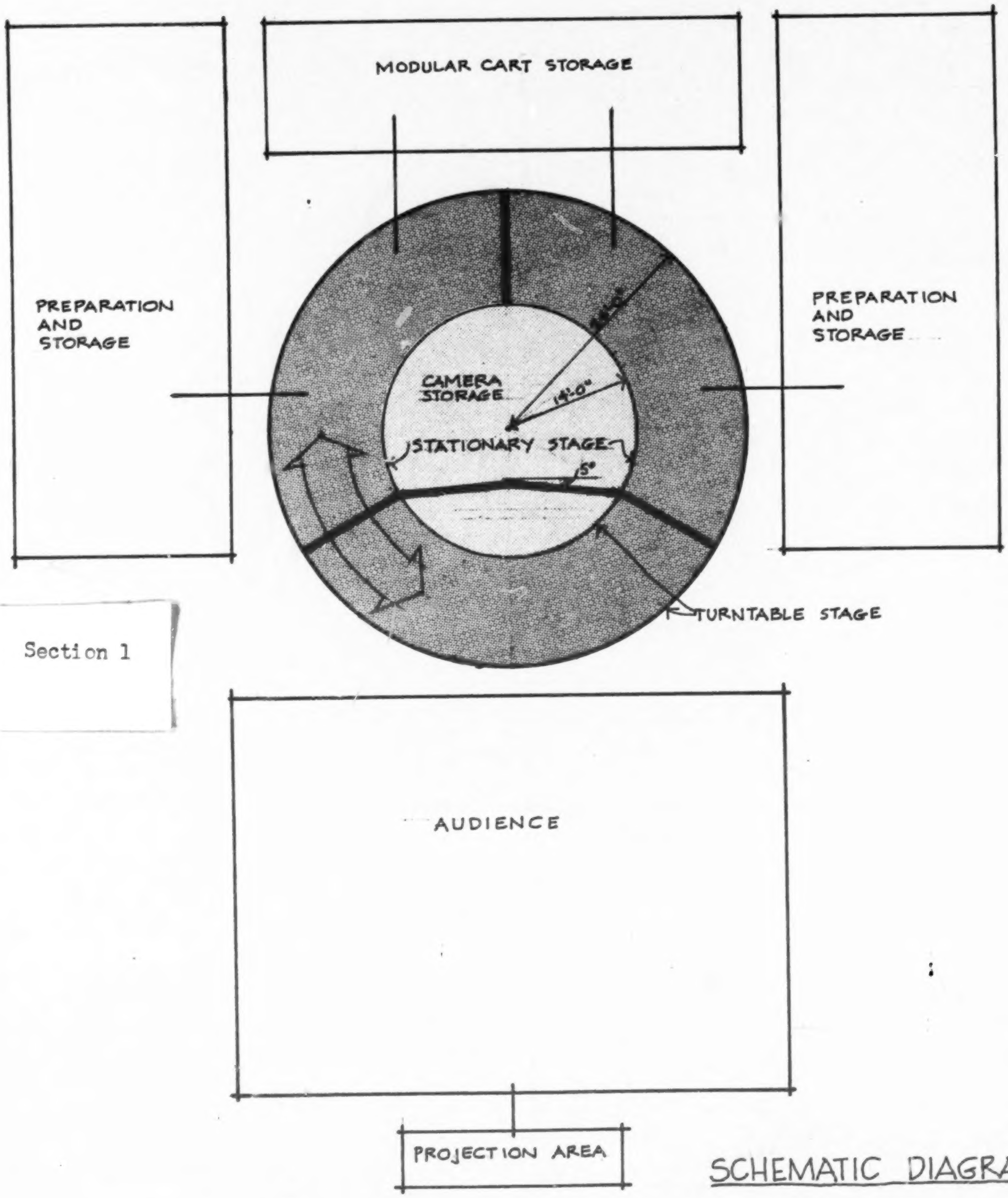
The stage consists of two parts; the inner circular disk, 28 feet in diameter, is fixed and the outer ring, 12 feet wide, rotates. The two central screens for front projection, with blackboards beneath, are located on the fixed disk. The side walls, each of which has a screen for the overhead projector, are located on the outer ring of the stage and, when moved into position, close the audience area from the preparation and storage areas.

The use of the three-part stage permits the preparation of materials for two additional classes, while the third is in progress. Because this scheme is for front projection there is no rear-projection booth over the stage and demonstrations are not limited in height, but may be up to 20 feet high.

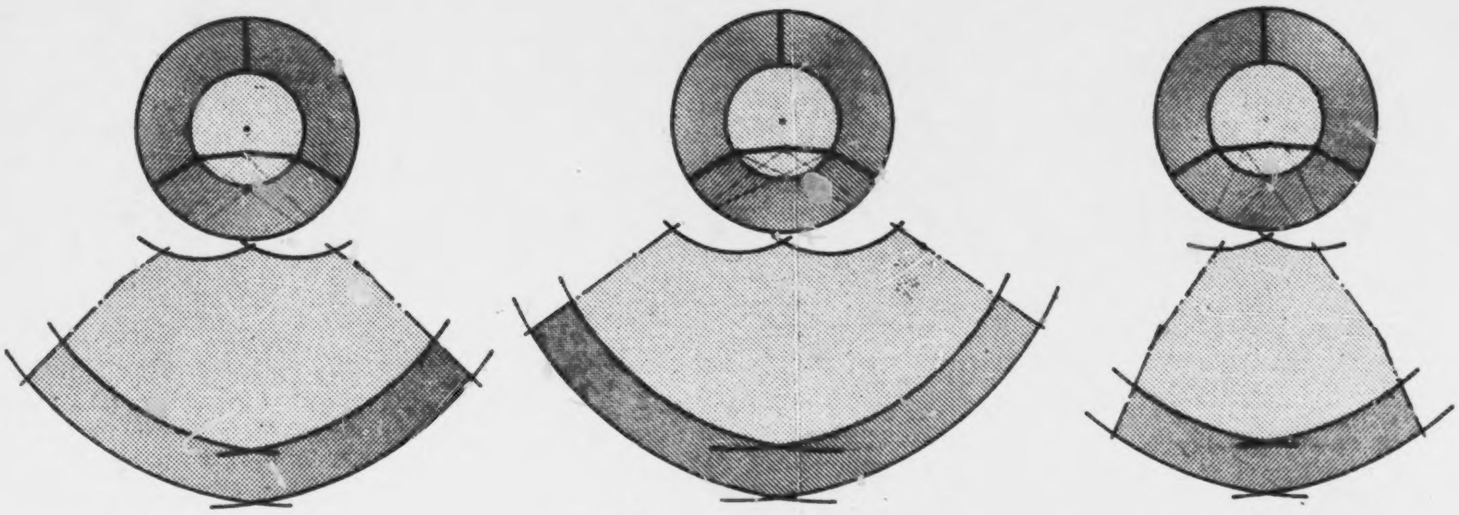
The "audience-arrangement" diagrams show the possible capacities for three different types of viewing areas. The resulting capacities range from 245 to 620 as based on maximum 14-seat rows and auditorium-type seating.

As in the other large capacity schemes, extensive preparation, storage, and modular cart areas must be included to support the functioning of the facility.

Section 1


MODULAR CART STORAGE
PREPARATION AND STORAGE
PREPARATION AND STORAGE
CAMERA STORAGE
14'-0"
STATIONARY STAGE
5°
TURNTABLE STAGE
AUDIENCE
PROJECTION AREA

SCHEMATIC DIAGRAM

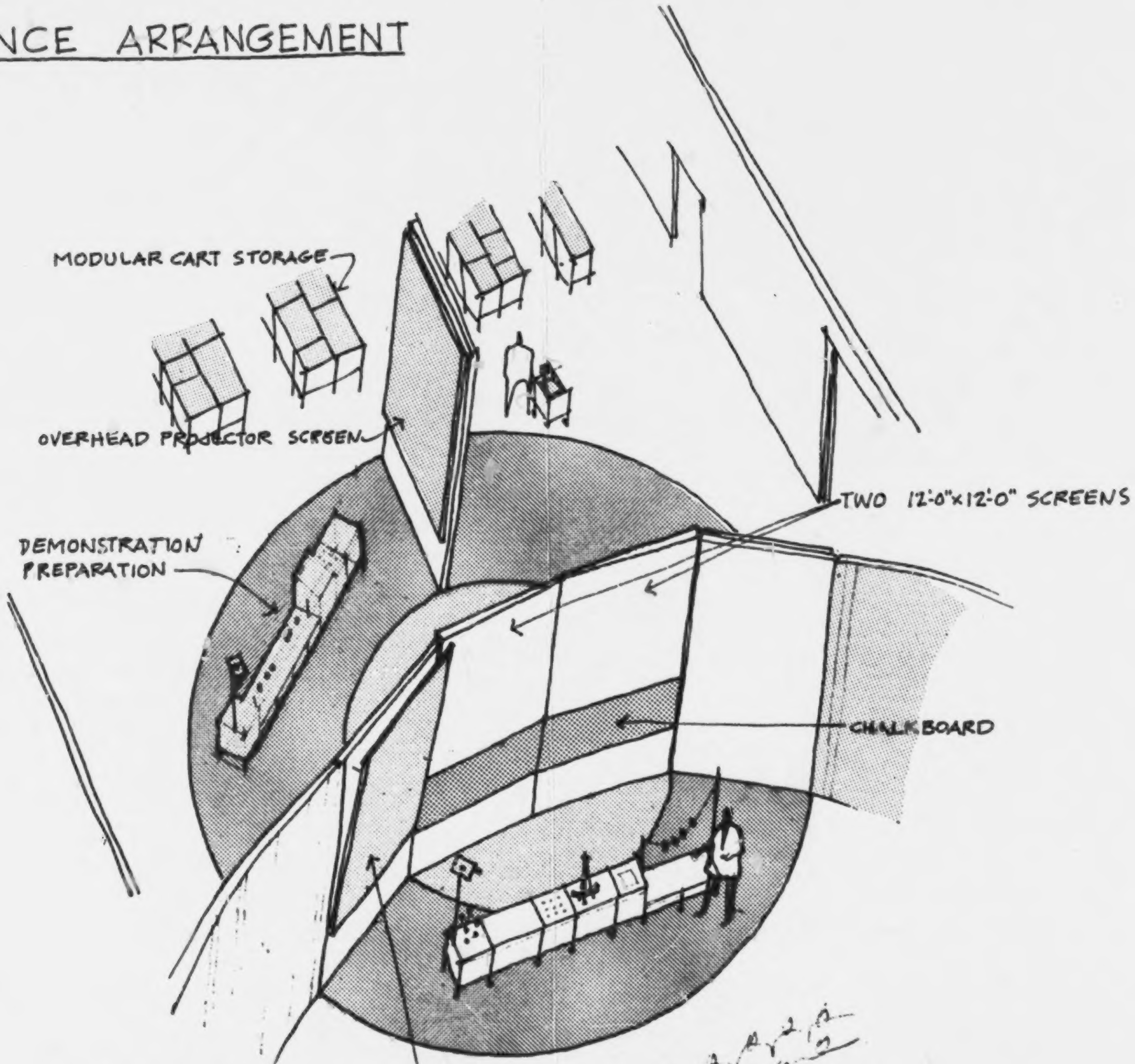


40° EDGE ANGLE
CAPACITY
2W-6W 365
2W-7W 535

30° EDGE ANGLE
CAPACITY
2W-6W 425
2W-7W 620

60° CENTERLINE
CAPACITY
2W-6W 245
2W-7W 355

## AUDIENCE ARRANGEMENT


MODULAR CART STORAGE
OVERHEAD PROJECTOR SCREEN
TWO 12'-0"x12'-0" SCREENS
DEMONSTRATION PREPARATION
CHALKBOARD
OVERHEAD PROJECTOR SCREEN

Section 2

Design Studies

SCHEME E

Design Studies

## DESIGN ANALYSIS - SCHEME E

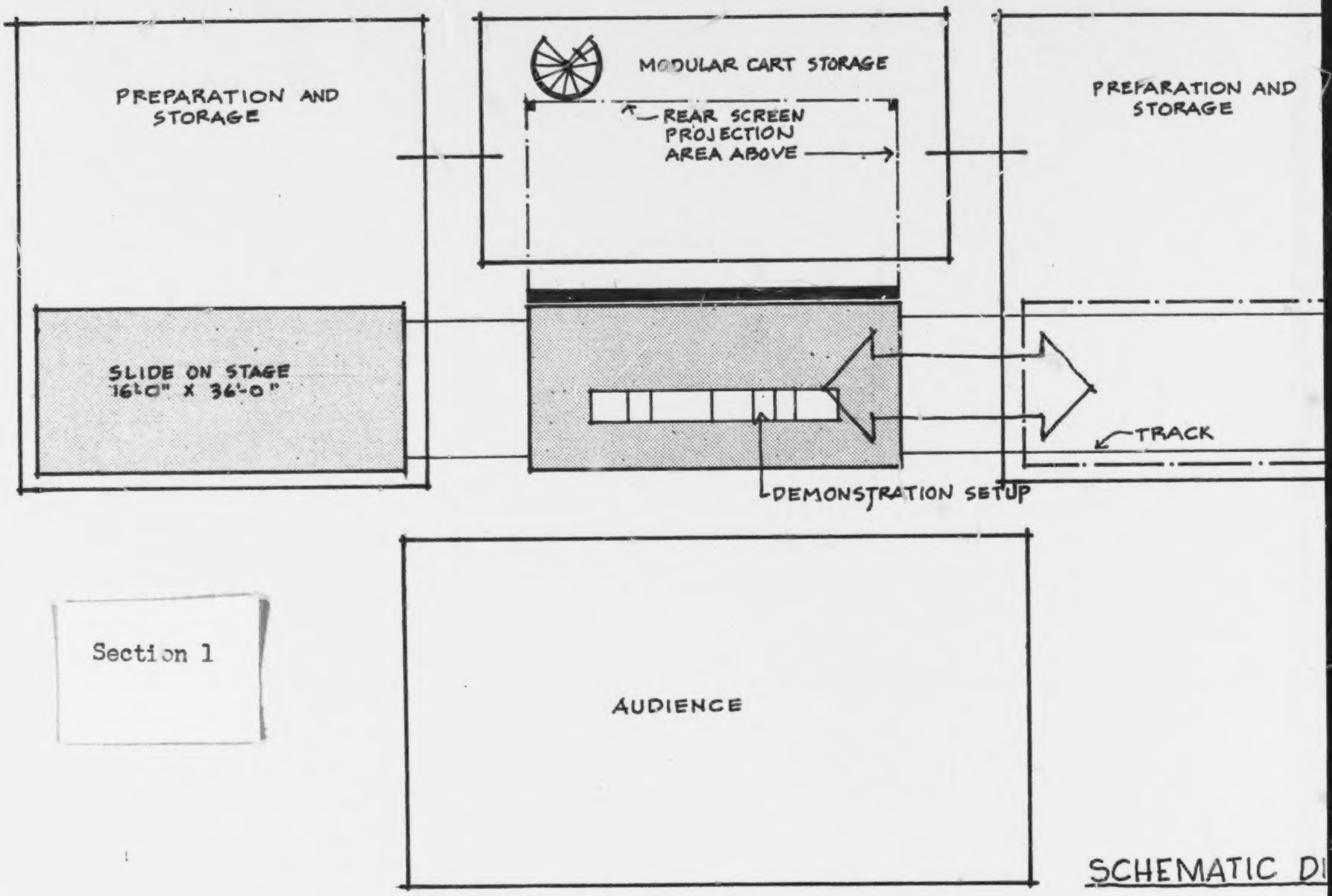
Two 16 by 36 foot slide-on stages form the basis for achieving flexibility of use in this Scheme E. If demonstration apparatus or equipment is not needed for a class, the two stages can be located out of position in the side preparation and storage areas, and the center area is left clear. Of course, a lectern or several module carts could be used in such a case, as they do not necessarily need to be placed on one of the slide-on stages.

With the stages in the preparation areas, demonstration equipment and apparatus can be set on them in anticipation of succeeding classes. Modular carts may form the basis for such set-ups. The utilities may be handled by use of one or more "utility carts" on the stage. All utilities can be connected and tried out with the stages out of position. The use of flexible connections, in a utility trough, is an alternate to the use of the utility carts. A portable screen may be used to test out projection equipment while the stage is in the preparation area. Demonstrations are not limited in height by the rear projection booth, and some apparatus can be hung from the equipment lifts above the center area.

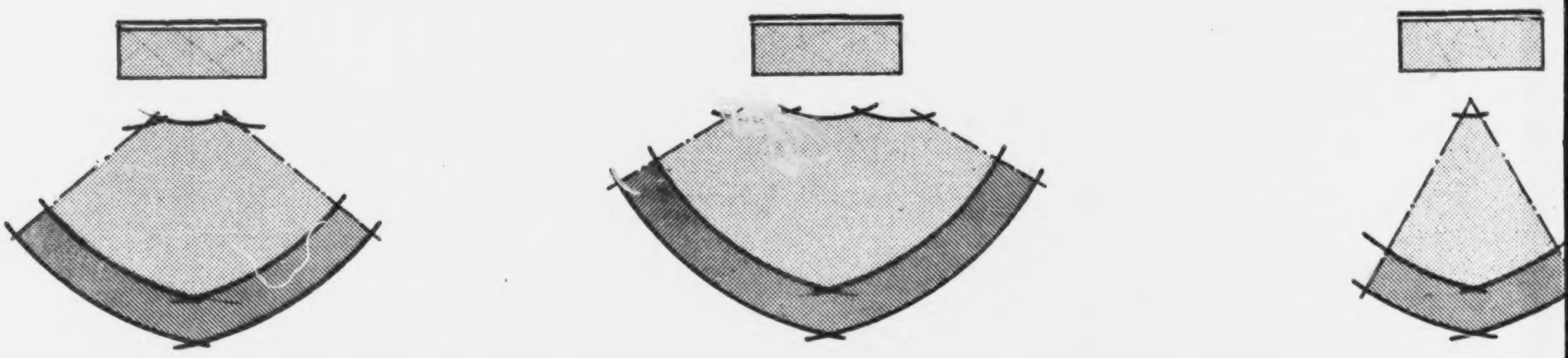
Three simultaneous images may be projected from the rear projection area on the screen which is 36 feet wide and 12 feet high. Some projectors, due to longer required projection distances, may be accommodated by indirect projection using mirrors. If an overhead projector is desired, an auxiliary reflective screen can be lowered from a pocket in the ceiling.

The three diagrams at the lower left indicate various audience arrangements with corresponding capacities.

Section 1


PREPARATION AND STORAGE
MODULAR CART STORAGE
REAR SCREEN PROJECTION AREA ABOVE
PREPARATION AND STORAGE
SLIDE ON STAGE 16'-0" X 36'-0"
TRACK
DEMONSTRATION SETUP
AUDIENCE

SCHEMATIC DI



40° EDGE ANGLE
CAPACITY
2W-6W 260
2W-7W 400

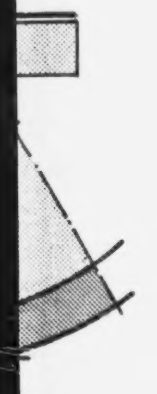
30° EDGE ANGLE
CAPACITY
2W-6W 335
2W-7W 515

60° CENTERL
CAPACITY
2W-6W 14
2W-7W 22

AUDIENCE ARRANGEMEN

F

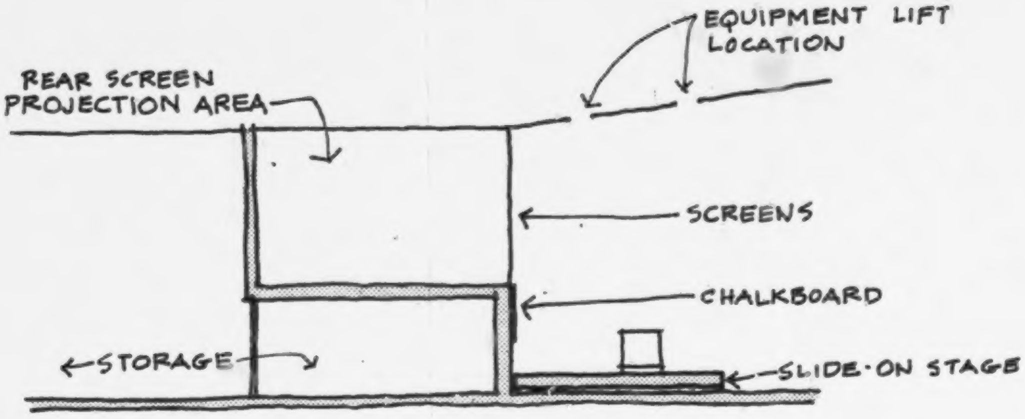
C DIAGRAM



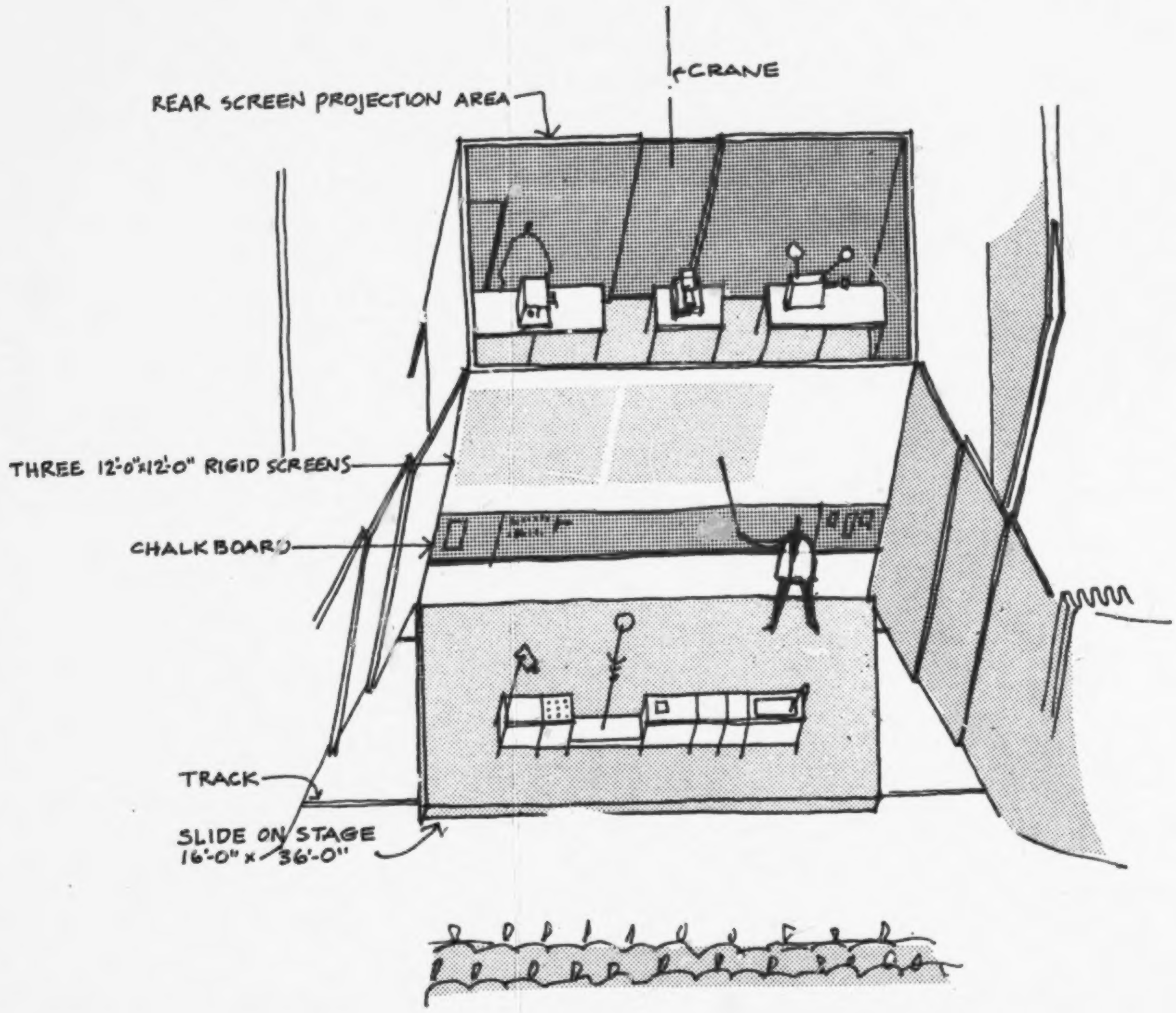
TERLINE

140
225

MENT


EQUIPMENT LIFT LOCATION
REAR SCREEN PROJECTION AREA
SCREENS
CHALKBOARD
STORAGE
SLIDE-ON STAGE

TYPICAL SECTION


CRANE
REAR SCREEN PROJECTION AREA
THREE 12'-0"x12'-0" RIGID SCREENS
CHALKBOARD
TRACK
SLIDE ON STAGE 16'-0" x 36'-0"

Section 2

Design Studies

SCHEME F

Design Studies

## DESIGN ANALYSIS - SCHEME F

A seating area based on optimum conditions for viewing projected images on two adjacent eight-foot screens determines the shape of the room in this scheme. Approximately 200 students can be accommodated. Access to the room is off a corridor alcove, adjacent to an auxiliary storage or coat room.

By extend~~ing the~~ splayed walls that follow the side limits of the viewing area, a triangular rear projection area is provided behind the screens. The general form resulting is best suited for use in combination with other rooms of the same shape. When this is done, as indicated in the lower left hand sketch, the rear projection spaces for all rooms, which occur at an upper level, are connected and permit one or two technicians to maintain and operate the projection equipment for a number of such spaces. A preparation and storage area for each classroom is provided on the lower level, and these spaces are also interconnected.

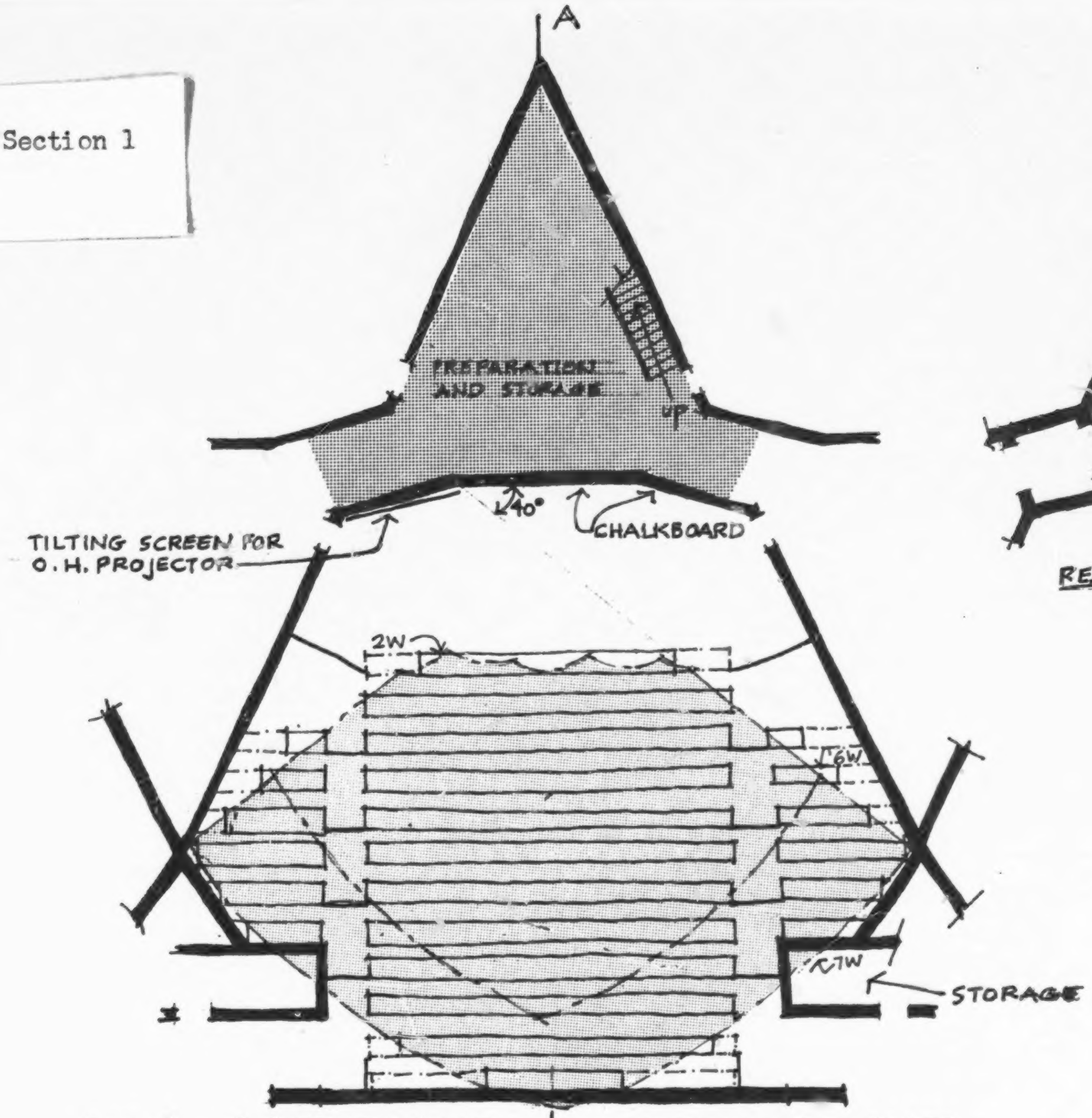
The viewing area shown in the basic scheme is bounded by lines from the opposite screen edges and extending at 40 degree angles from the screen plane. If these angles are reduced to 30 degrees, as would be appropriate for some projected material, the angle between the side walls of the room can logically be made 60 degrees. If desired six spaces of this shape may be arranged around a central projection core on the upper level and central preparation and storage on the lower level. Such a combined facility would have a capacity of approximately 1200 students.

By use of two rear projection screens, two simultaneous images (either film or slide projected) can be shown, or one of the two images may be projected by television. In addition a third image may be projected on a third screen at the left of the two center screens using the overhead projector. The corresponding surface on the opposite side of the room may be used for shadow projection or as a display surface for large charts or graphs. The preparation and storage areas adjacent to each room will permit the space to be used for lecture-demonstrations employing large scale models and apparatus concurrently with the use of projection facilities.

The seating is arranged with a maximum of 14 seats in a row, resulting in two aisles. If continental seating were substituted, these aisles could be moved to the side walls. Since the floor is stepped, fixed seating is probably most desirable, and pedestal chairs with a continuous table top would probably be most appropriate. An alternative would be to provide a continuous writing surface with folding seats.

Although the design of the room is predicated on rear projection, including rear-projection of televised images, television might instead be received by monitors located near the side walls. This would not be as desirable, from the standpoint of a well-integrated presentation, as a single projected image appearing on the central display surface.

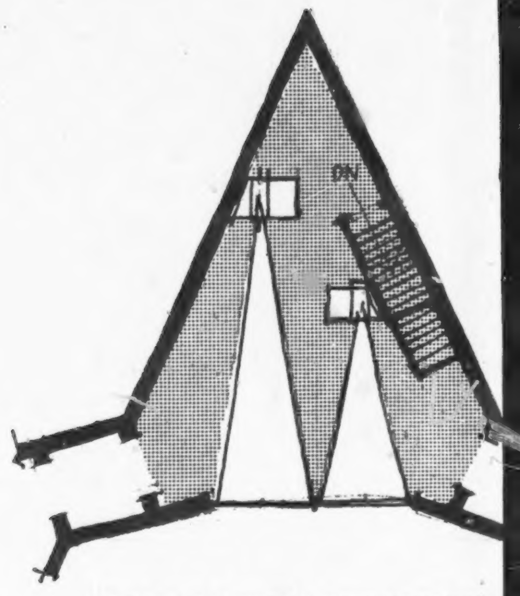
Section 1


A
PREPARATION AND STORAGE
UP
40°
CHALKBOARD
TILTING SCREEN FOR O.H. PROJECTOR
2W
6W
7W
STORAGE

PLAN - 40° EDGE ANGLE
8'-0" W - 2W - 7W

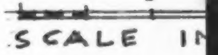
CAPACITY 200 SEATS

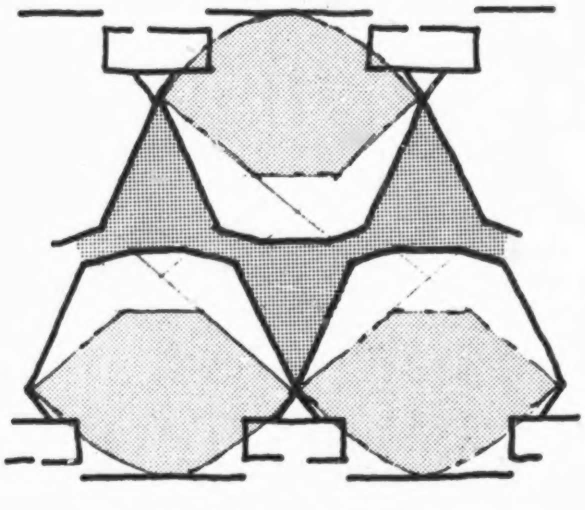
A



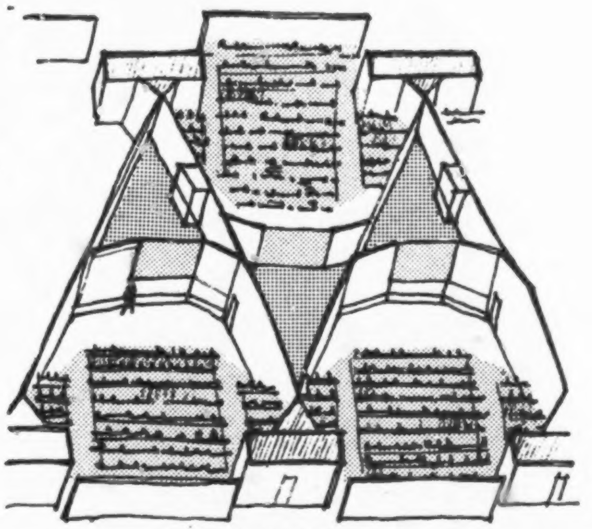
REAR SCREEN PROJECTION A

10


5 0 5
SCALE IN



40° EDGE ANGLE GROUP



ISOMETRIC

3

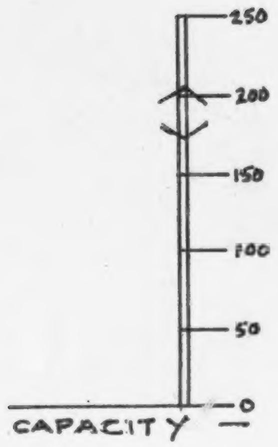
## ROOM FUNCTION

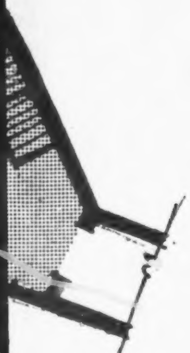
AC

VIEWING : REAR PROJECTED MATERIAL
OVERHEAD PROJECTOR
TELEVISION MONITORS OR
REAR PROJECTED TELEVISION

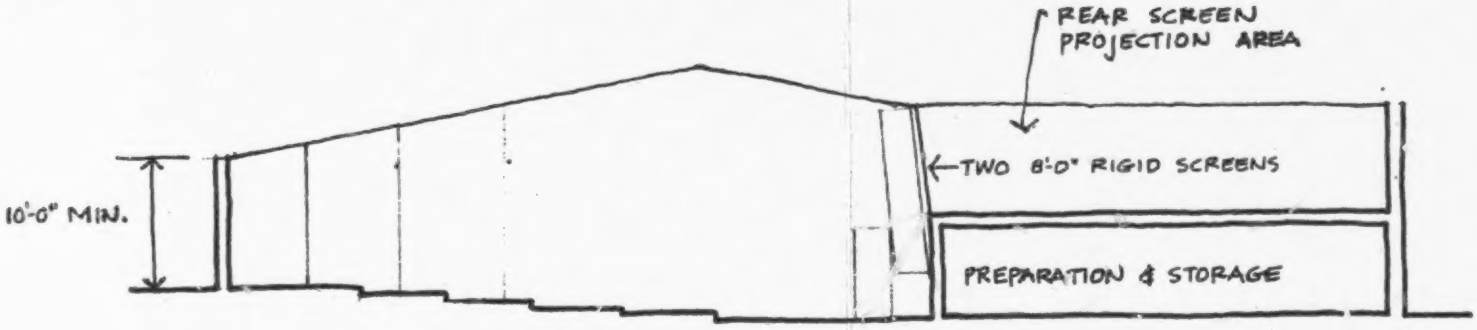
SUPPLEMENTARY : CHALKBOARD
LIVE DEMONSTRATI
DISCUSSION

F

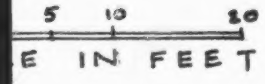

250
200
150
100
50
0
CAPACITY

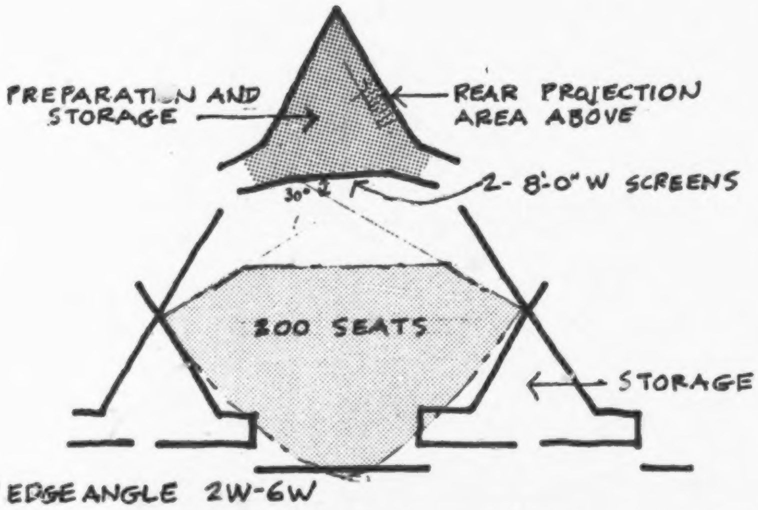


CTION AREA

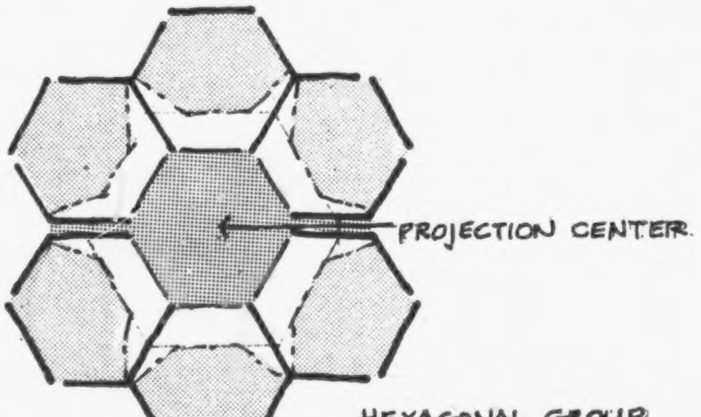

REAR SCREEN PROJECTION AREA
TWO 8'-0" RIGID SCREENS
10'-0" MIN.
PREPARATION & STORAGE

SECTION AA


5
10
20
E IN FEET


PREPARATION AND STORAGE
REAR PROJECTION AREA ABOVE
30°
2- 8'-0" W SCREENS
200 SEATS
STORAGE
30° EDGE ANGLE 2W-6W

HEXAGONAL SPACE


PROJECTION CENTER

HEXAGONAL GROUP
CAPACITY 1200 SEATS

## ACOUSTICAL TREATMENT

D — HARD REFLECTIVE CEILING MATERIAL
STRATIONS — ABSORPTIVE SURFACE ON REAR WALLS

## LIGHTING

TABLET SURFACE - RECESSED DOWN LIGHTS
GENERAL ILLUMINATION - PERIMETER COVE LIGHTS
AUXILIARY - SPOTS ON CHALKBOARD & INSTRUCTIONAL AREA

Section 2

Design Studies

SCHEME G

## DESIGN ANALYSIS - SCHEME G

The arrangement of the seating area in this scheme is very similar to Scheme F. The significant feature is, however, the use of a central "multiplexing area" serving two back-to-back learning spaces. From this multiplexing area, two simultaneous images can be rear-projected into each room. The locations of the mirrors in relation to the projectors and screens will be based on the type of projector, the focal length of lens, and the required "throw" distance. The mirrors can also be rotated to change the projection beams from one room to the other. Technicians would normally not need to enter the multiplexing area, but would ready the equipment from the two side projector areas.

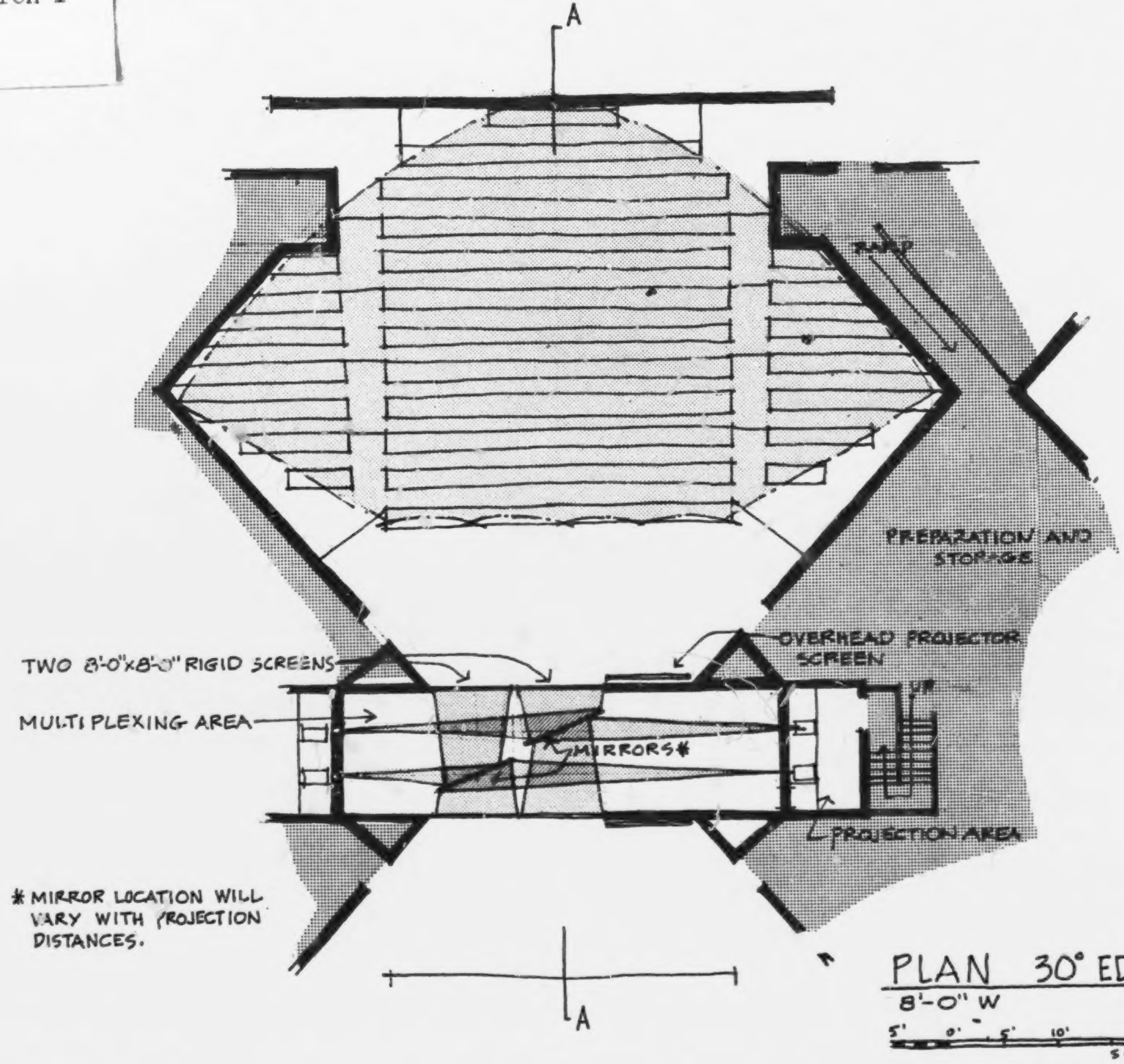
Beneath the multiplexing area is a storage room which is contiguous with the large preparation and storage areas between each learning space. These areas permit demonstrations and apparatus to be used as part of the instructional materials, and a number of "modular-carts" might be available for such purposes. Access to the preparation areas is both from the corridors and the front of the classrooms.

In each room, in addition to the two 8 foot screens for rear-projection, there is a tilting reflective screen for use with the overhead projector. Chalkboards and tackboards form a band beneath the screens. If monitors were to be used for receiving televised instruction, they would be located near the side walls and down the center of the seating area. Probably six to eight, 24 or 27 inch monitors would provide adequate viewing.

The capacity of this room, within the shaded optimum viewing area, is 235. If the additional seats shown outside the shaded area were used, another 15 to 20 students could be accommodated.

The use of indirect projection (multiplexing) permits utilizing the advantages of rear projection, without demanding the larger space that would be required if direct rear-projection were used.

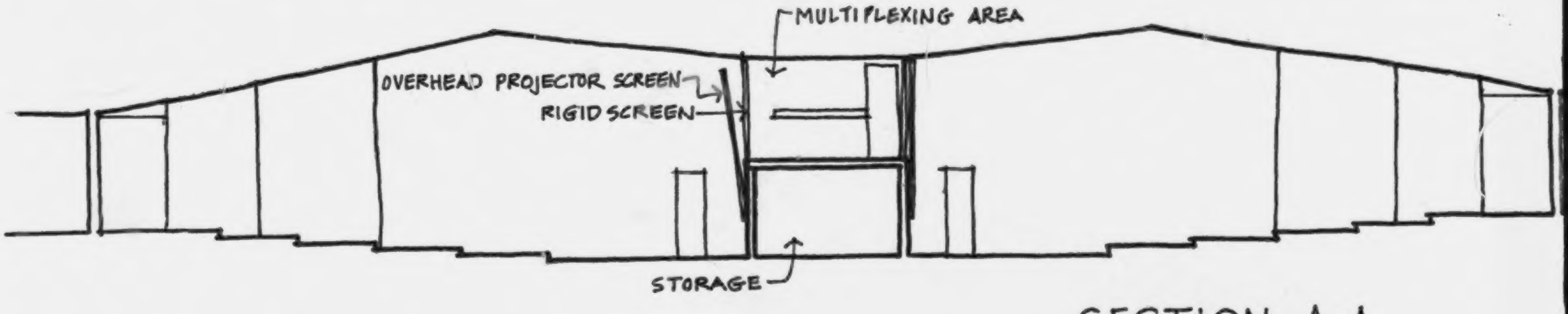
Section 1


A
RAMP
PREPARATION AND STORAGE
TWO 8'-0"x8'-0" RIGID SCREENS
OVERHEAD PROJECTOR SCREEN
MULTIPLEXING AREA
MIRRORS*
UP
PROJECTION AREA
* MIRROR LOCATION WILL VARY WITH PROJECTION DISTANCES.
A

PLAN 30° EDGE ANGLE

8'-0" W 2W - 7W

5' 0' 5' 10' 20'
SCALE IN FEET.


MULTIPLEXING AREA
OVERHEAD PROJECTOR SCREEN
RIGID SCREEN
STORAGE

SECTION· A-A

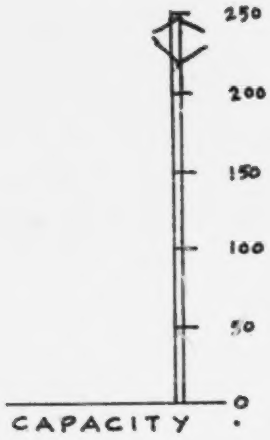
## ROOM FUNCTION

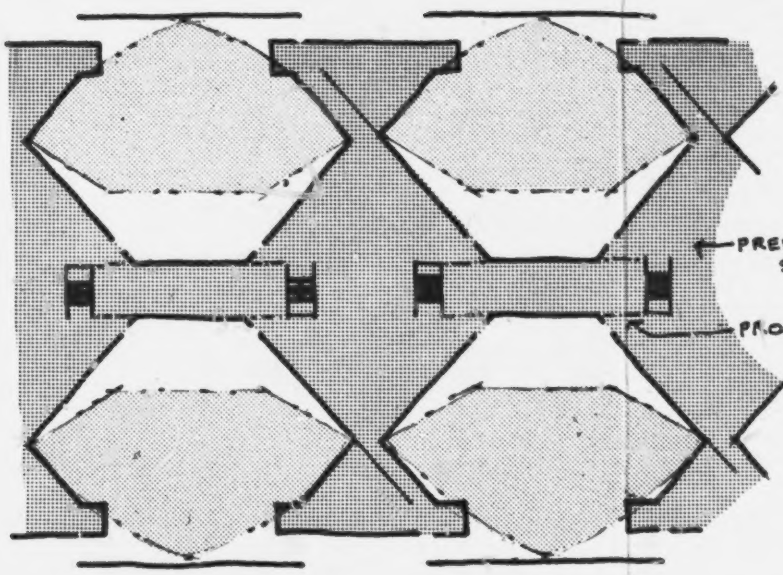
AC

VIEWING
- REAR PROJECTED MATERIALS
- OVERHEAD PROJECTOR
- REAR PROJECTED TELEVISION OR TELEVISION MONITORS

SUPPLEMENTARY:
- CHALKBOARD
- LIVE DEMONSTRATIONS
- DISCUSSION

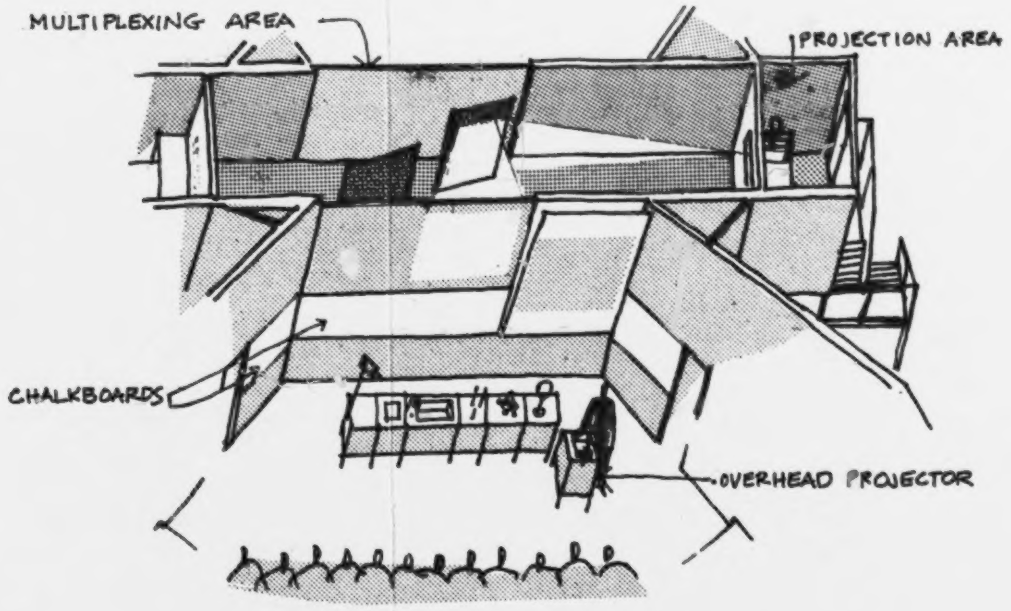
F




PREPARATION AND STORAGE
PROJECTION ABOVE

GROUP PLAN

G


MULTIPLEXING AREA
PROJECTION AREA
CHALKBOARDS
OVERHEAD PROJECTOR

GLE
7W
ET.

Section 2

ACOUSTICAL TREATMENT

HARD REFLECTIVE CEILING MATERIAL
ABSORPTIVE SURFACE ON REAR WALLS

LIGHTING

TABLET SURFACE - RECESSED DOWN LIGHTS
GENERAL ILLUMINATION - PERIMETER COVE LIGHTS
AUXILIARY - SPOTS ON CHALKBOARD AND INSTRUCTIONAL AREA.

F

**Design Studies**

**SCHEME H**

Design Studies

## DESIGN ANALYSIS - SCHEME H

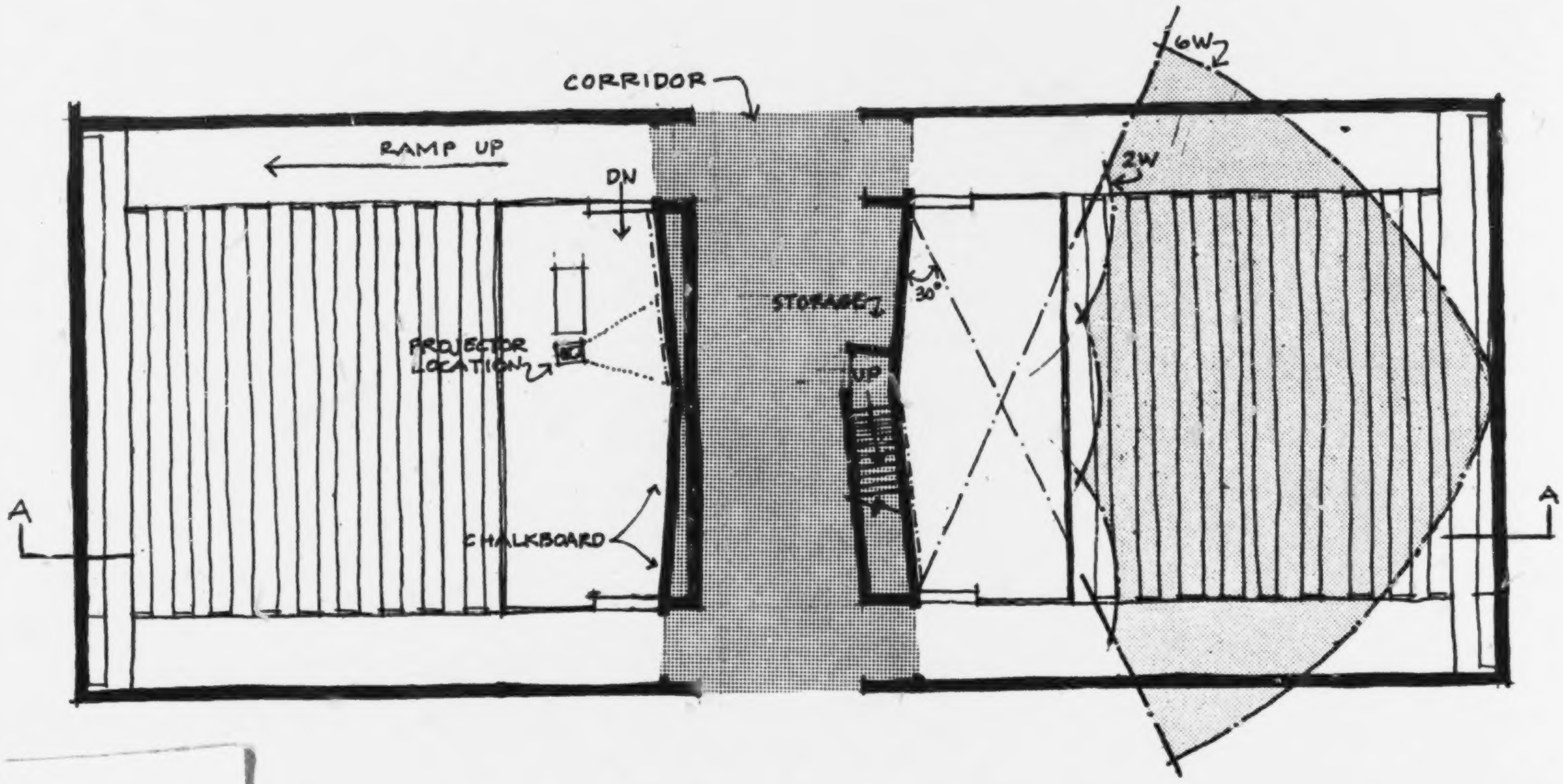
In some instances it may be desirable to have access to a pair or several pairs of learning spaces from a central, double-loaded corridor. If this is the case, the space above the corridor may logically become a rear-projection area serving the classrooms on either side. Such an arrangement is the basis of Scheme H.

The learning spaces are rectangular in form to indicate a possible solution for converting existing space, and because rooms this shape fit together readily. However, this arrangement does not permit the extensive preparation and storage areas that have been included in most of the other schemes. A viewing area based on 2W and 6W, with side angles of 30°, is indicated on the plan. It will be noted that not all of the 145 seats fall within these limits. However, if the maximum distance were increased to 7W all seats would be included. If Scheme H were not based on a rectangular shape, but if the walls enclosed the total viewing area, as in Scheme G, the capacity would be increased substantially.

The rear-projection area, as shown on the "mezzanine plan", is divided in half so that the setting-up of equipment in one room does not interfere with the projection of materials in the next. If several pairs of these learning spaces were built side-by-side, the rear-projection areas for all would be contiguous, permitting one or two technicians to service a number of rooms. With this rear-projection arrangement, the rear-projection screen in either room occurs to one side with reflective screens for over-head and shadow projection on the other.

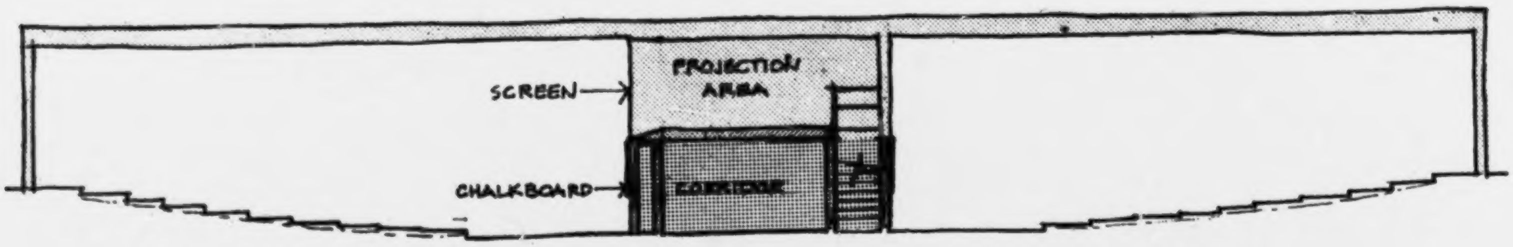
This basic arrangement (rear-projection area over the corridor) would, of course, be used for single rooms as well as for pairs. Also, if the corridor were located at the rear of the learning spaces, the space under the projection area could be used for preparation and storage.

Section 1


CORRIDOR
RAMP UP
DN
PROJECTOR LOCATION
STORAGE
UP
30°
6W
2W
CHALKBOARD
A
A

PLAN AND AUDIENCE PATTERN

5 0 10 20
SCALE IN FEET


PROJECTION AREA
SCREEN
CHALKBOARD
CORRIDOR

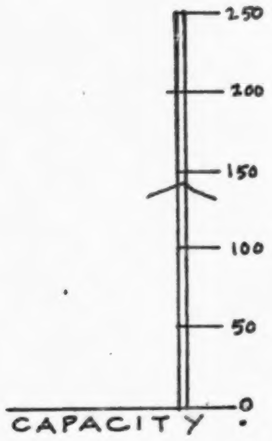
SECTION A-A

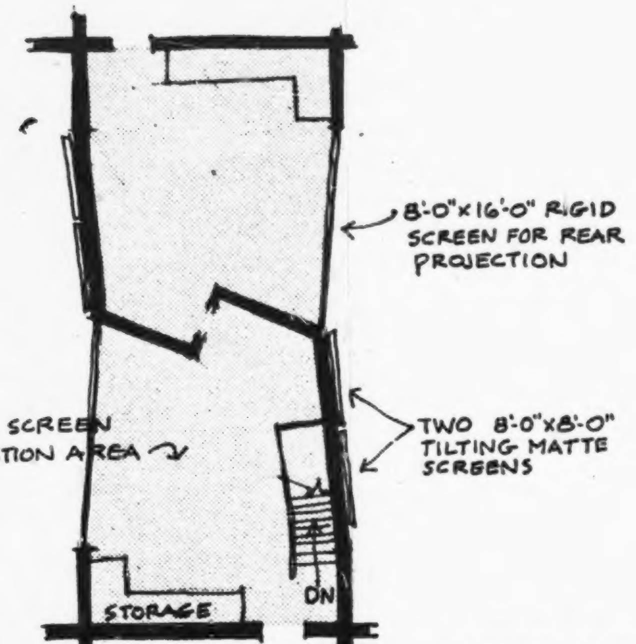
ROOM FUNCTION

VIEWING : REAR PROJECTED MATERIAL
OVERHEAD PROJECTOR
TELEVISION MONITORS OR
REAR PROJECTED TELEVISION

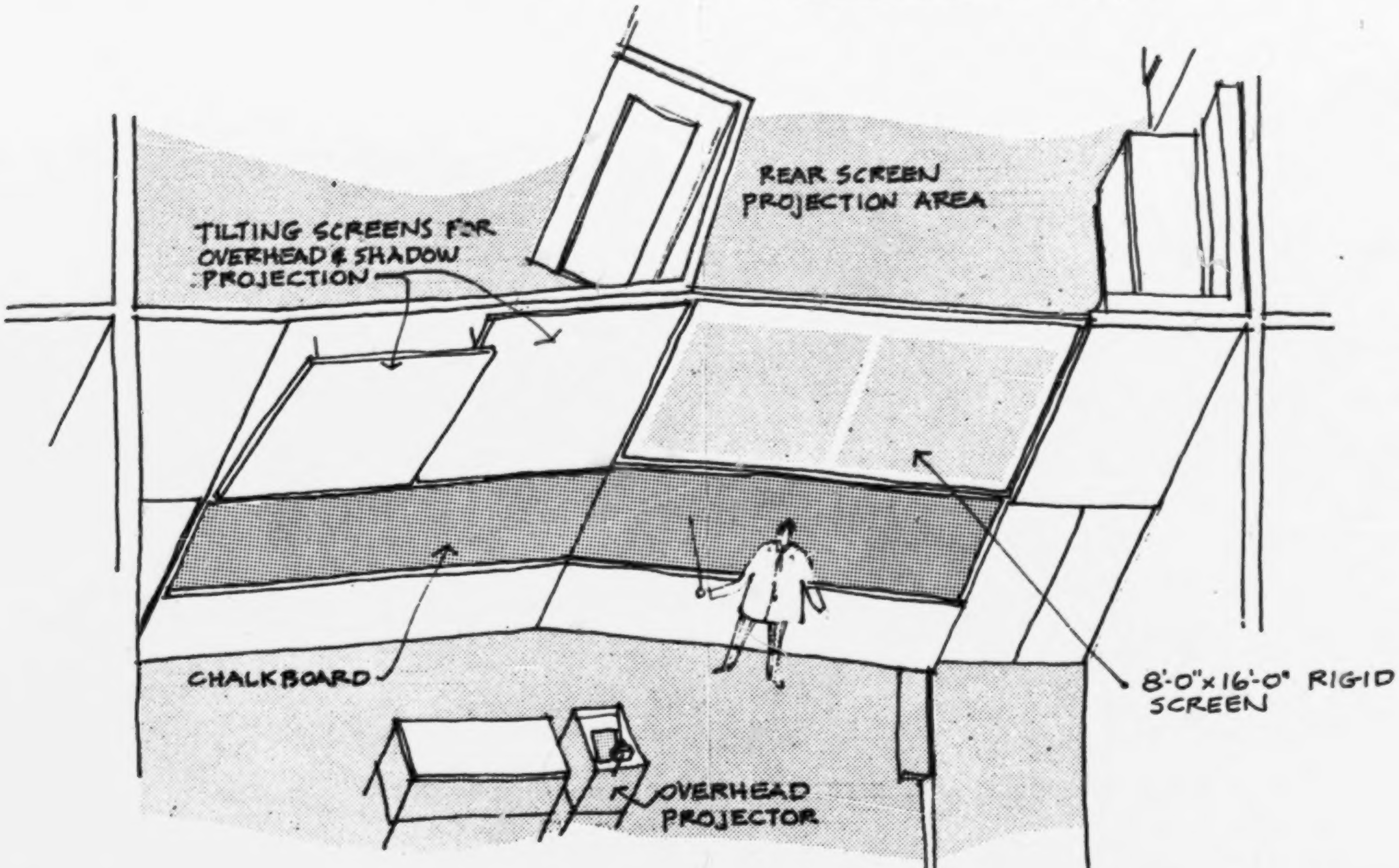
SUPPLEMENTARY : CHALKBOARD
LIVE DEMONSTRATIONS
DISCUSSION

F




8'-0"x16'-0" RIGID SCREEN FOR REAR PROJECTION
REAR SCREEN PROJECTION AREA
TWO 8'-0"x8'-0" TILTING MATTE SCREENS
STORAGE
DN

## MEZZANINE PLAN


REAR SCREEN PROJECTION AREA
TILTING SCREENS FOR OVERHEAD & SHADOW PROJECTION
CHALKBOARD
8'-0"x16'-0" RIGID SCREEN
OVERHEAD PROJECTOR

Section 2

**ACOUSTICAL TREATMENT:**

HARD REFLECTIVE CEILING MATERIAL
ABSORPTIVE MATERIAL ON REAR WALLS

**LIGHTING**

TABLET SURFACE - RECESSED DOWN LIGHTS
GENERAL ILLUMINATION - PERIMETER COVE LIGHTS
AUXILIARY - SPOTS ON CHALKBOARD & INSTRUCTION AREA.

Design Studies

SCHEME I

Design Studies

## DESIGN ANALYSIS - SCHEME I

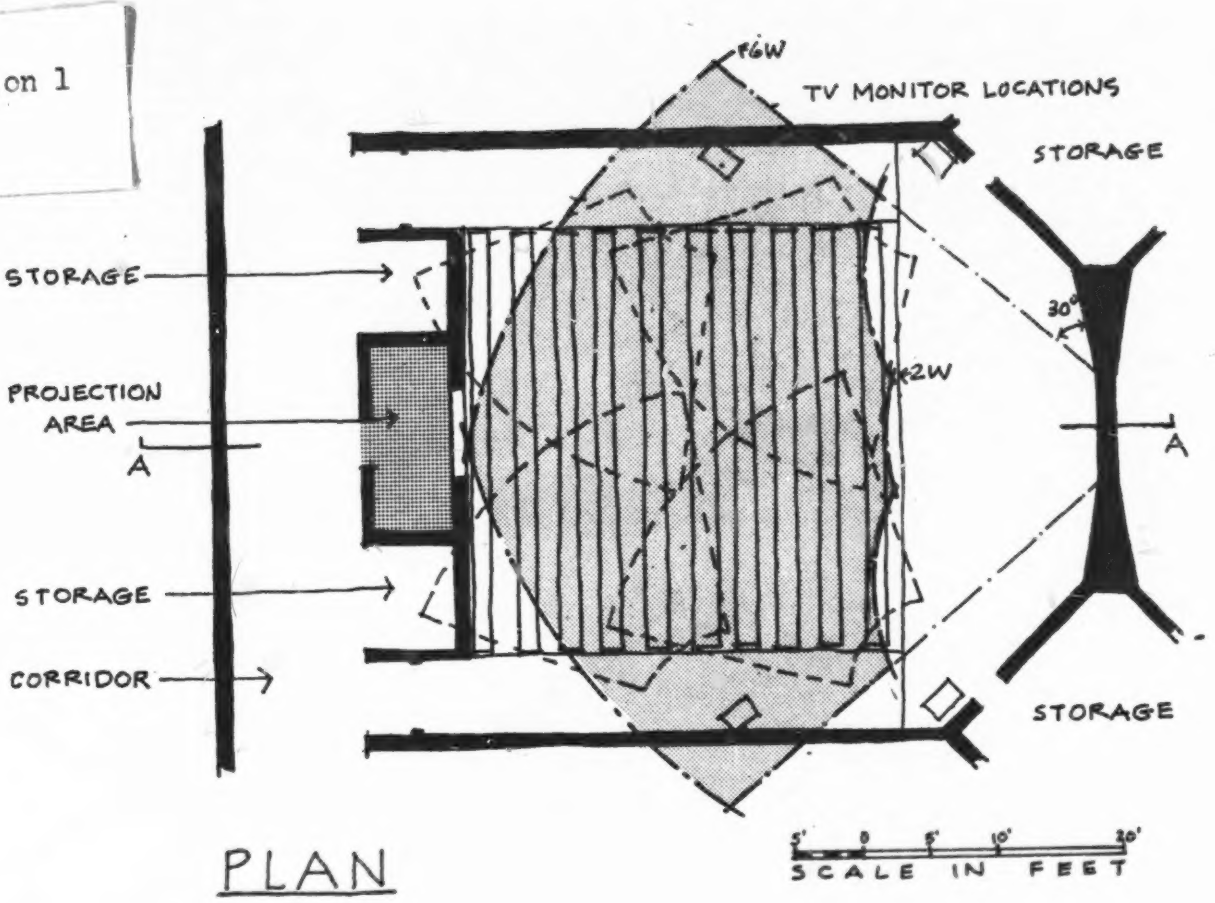
This scheme is somewhat similar in concept to Scheme H in that it is basically rectangular in plan, is adaptable to existing space, and would probably work best in pairs. The significant difference is that Scheme I is based on front-projection of materials instead of rear-projection as in Scheme H.

Three screens, 8 feet by 8 feet, are situated across the front of the space; one screen can be tilted for use with the overhead, opaque or shadow projectors. Other projectors would be located in the projection area at the rear of the viewing area. Access to the projection area is from the corridor which permits readying equipment without interfering with a class in session. Four television monitors, located along the side walls as shown on the plan, would give adequate coverage of the viewing area for TV reception. The viewing area, based on 2W and 6W would permit a capacity of 140 students arranged in 10 rows of 14 seats each.

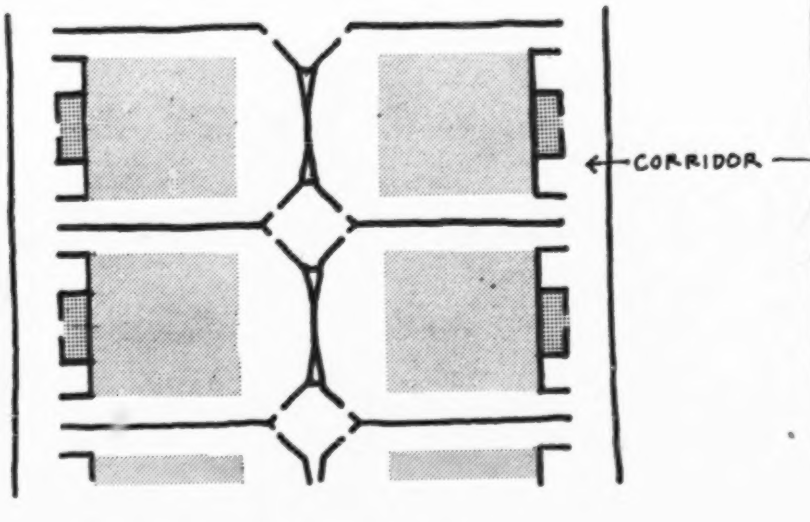
Two storage areas are accessible from the front of the room. Additional storage is available off the corridor on either side of the projection area. The plan in the lower left corner indicates the way four or more of these learning spaces would fit together. Each storage area could be commonly used by four rooms if it contained materials used in all spaces.

The alternate scheme indicates the plan arrangement if the rooms were reversed, end for end, resulting in a common projection core serving all rooms. This would be a very workable arrangement permitting one or two technicians to ready the projection equipment for a number of rooms without having to go to each individual projection area as they would in the basic scheme. However, the alternate arrangement has two possible drawbacks; first, the access to the rooms would be at the front near the screens and instructor station, and secondly, there would not be individual storage areas for each room.

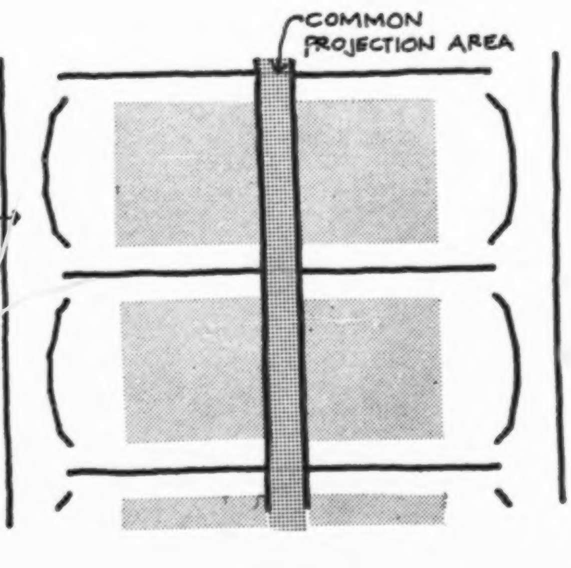
This Scheme I, though relatively simple, incorporates many significant design features.


F6W
TV MONITOR LOCATIONS
STORAGE
STORAGE
PROJECTION AREA
A
STORAGE
CORRIDOR
30°
2W
A
STORAGE
5' 0 5' 10' 20'
SCALE IN FEET

PLAN



PLAN FOR MULTIPLE UNITS.


COMMON PROJECTION AREA

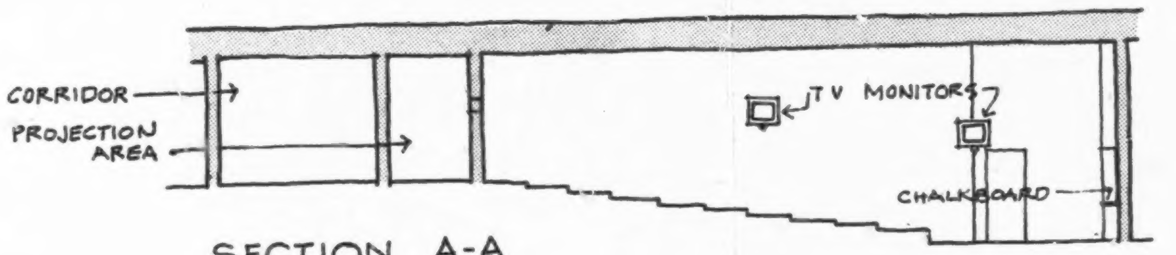
ALTERNATE SCHEME WITH COMMON PROJECTION AREA.

## ROOM FUNCTIONS

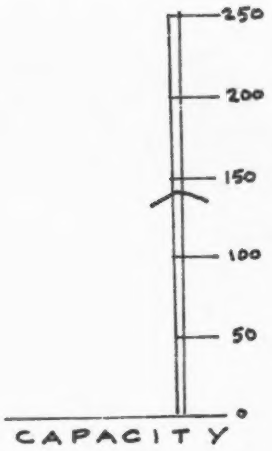
VIEWING : TV MONITORS
FRONT PROJECTED MATERIAL
OVERHEAD & SHADOW PROJECTION

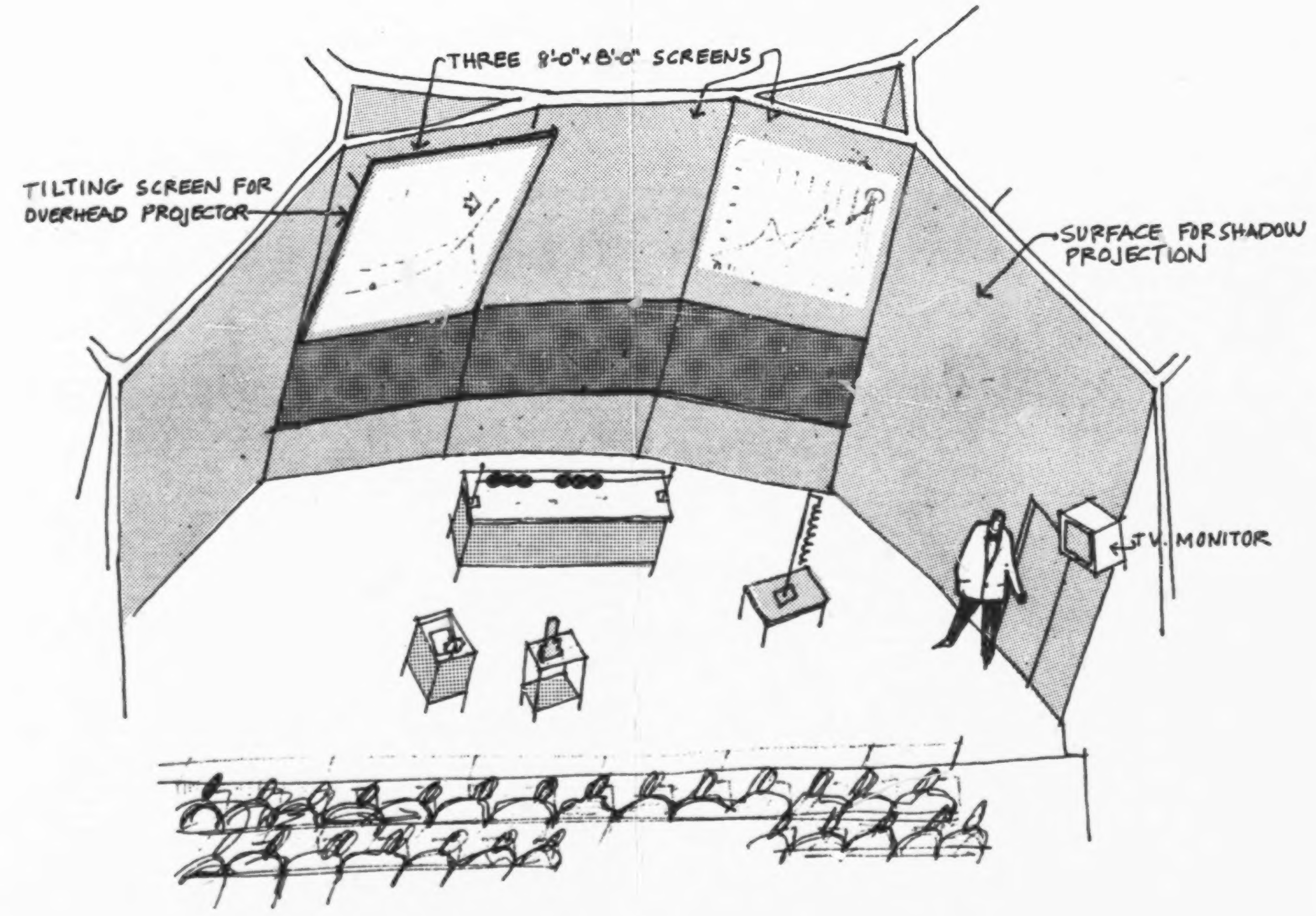
SUPPLEMENTARY : DISCUSSION
CHALKBOARD
DEMONSTRATIONS

F


CORRIDOR
PROJECTION AREA
TV MONITORS
CHALKBOARD

SECTION A-A




THREE 8'-0" x 8'-0" SCREENS
TILTING SCREEN FOR OVERHEAD PROJECTOR
SURFACE FOR SHADOW PROJECTION
T.V. MONITOR

Section 2

## ACOUSTICAL TREATMENT

HARD REFLECTIVE CEILING MATERIAL
ABSORPTIVE MATERIAL ON REAR WALLS

## LIGHTING

TABLET SURFACE - RECESSED DOWN LIGHTS
GENERAL ILLUMINATION - PERIMETER COVE LIGHTS
AUXILIARY - SPOTS ON CHALKBOARD AND INSTRUCTORS AREA.

F

Design Studies

SCHEME J

Design Studies

## DESIGN ANALYSIS - SCHEME J

In many instances it may be desirable to combine two different types of spaces in multiple units. This is of particular concern where the course and instructional methods call for a large group to be divided into smaller seminar-recitation groups following the expository section of a class presentation. Scheme J illustrates one possible approach to a facility to accommodate such situations.

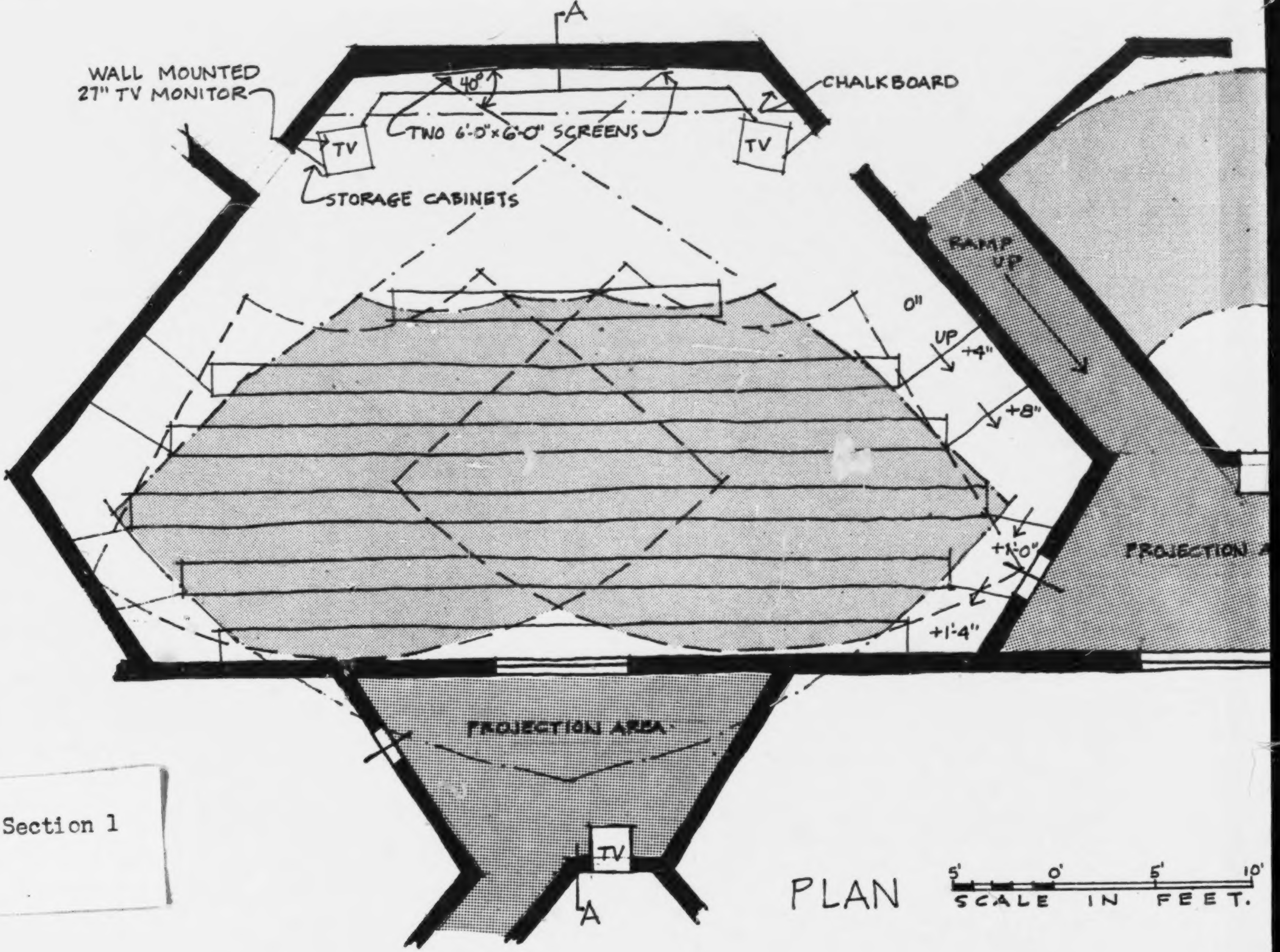
The large learning space is based on two six-foot screens and two TV monitors, and has a capacity with continental seating of about 90. This room is quite similar to Scheme K following; the difference in room shape results from the use of continental seating in lieu of the 14-seat row shown in K. Between each of these larger rooms is a TV - seminar room, and a projection area from which materials are front projected into the larger rooms.

The small room would have a flat floor permitting seating arrangements either for seminar groups or for groups watching a single TV monitor. The seminar arrangement (where the TV monitor could be used as a supplemental aid) would permit a capacity of 12 or so; the room as a TV viewing room would seat nearer 25. Access to the projection area is down a ramp from the corridor, which would permit readying of materials by technicians while classes are in session.

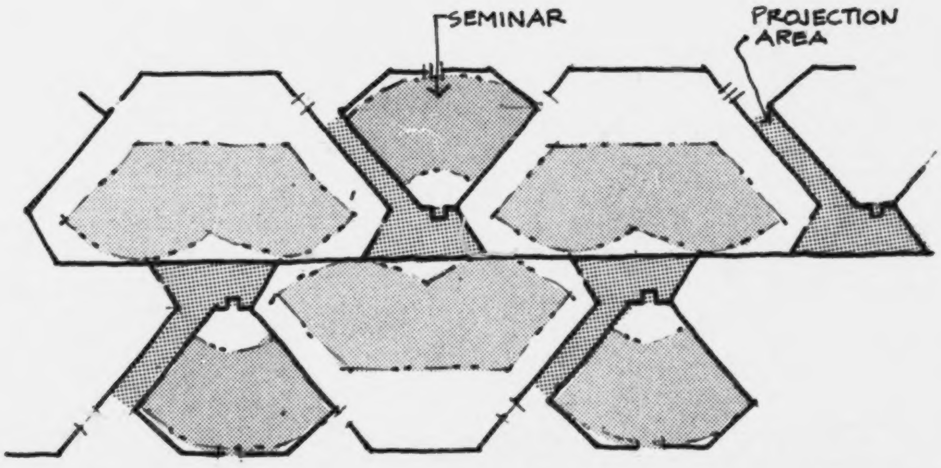
The lower left plan indicates a compact arrangement for several of these spaces. It would be possible to have each small room open directly off a larger room, thus permitting a class to break into two groups without going into the corridors. The center plan is an alternate arrangement of the large rooms which would result in a central classroom or storage area which could be accessible from all four surrounding rooms. The second alternate indicates the central area divided into two seminar spaces of 15 students each and two storage areas.

The possible arrangements for combining spaces of two functions are innumerable; Scheme J indicates simply one possibility.

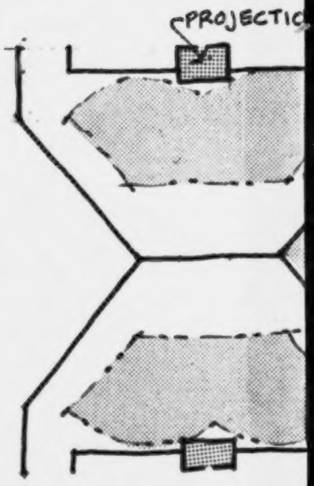
Section 1


A
WALL MOUNTED 27" TV MONITOR
40°
CHALKBOARD
TV
TWO 6'-0"×6'-0" SCREENS
TV
STORAGE CABINETS
RAMP UP
0"
UP +4"
+8"
+1'-0"
+1'-4"
PROJECTION A
PROJECTION AREA
TV
A
5' 0' 5' 10'
SCALE IN FEET.

PLAN


SEMINAR
PROJECTION AREA

MULTIPLE UNIT PLAN



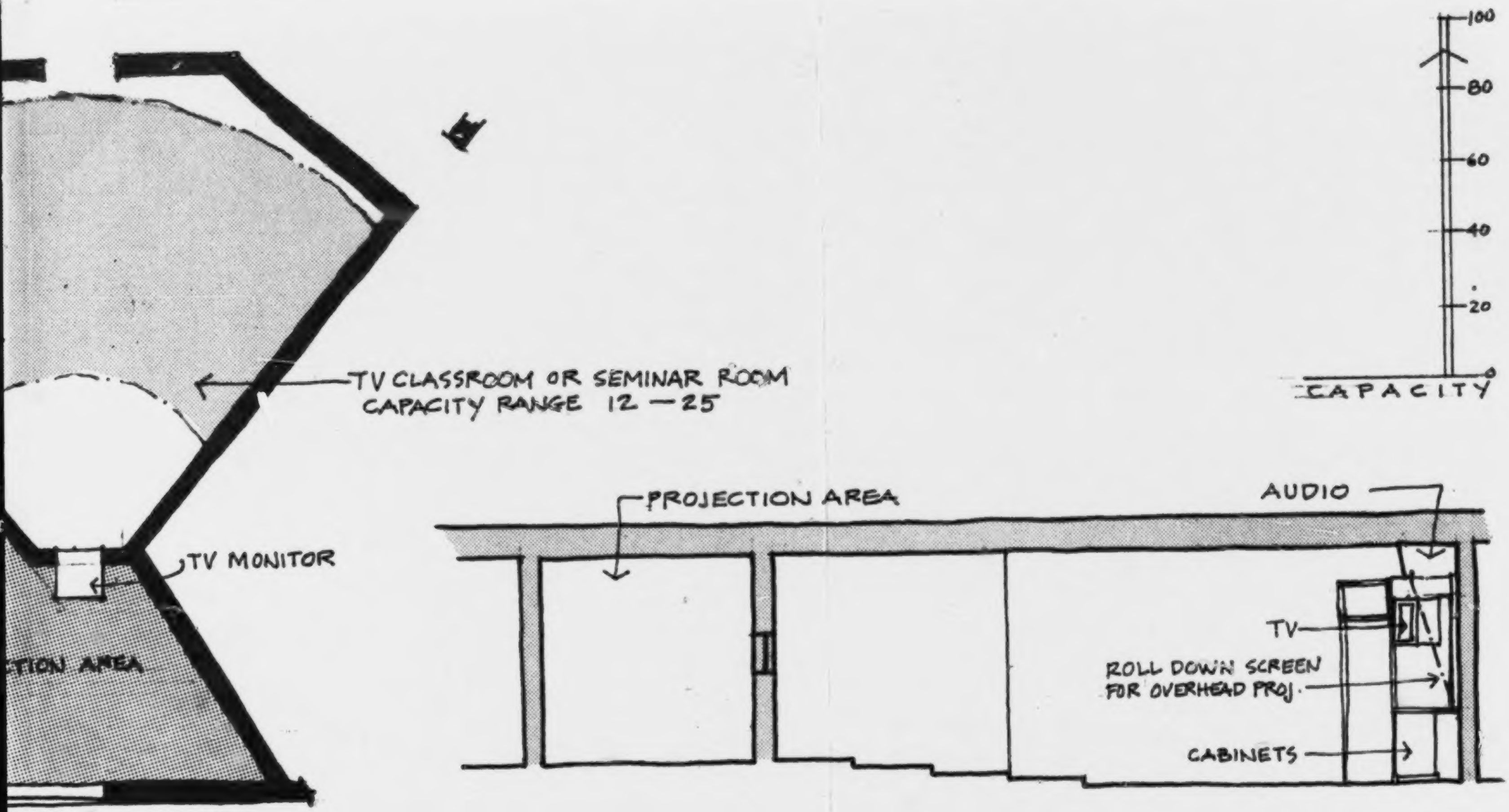
FRONT PRO

ROOM FUNCTION

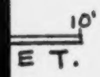
VIEWING : TV MONITORS
FRONT PROJECTED MATERIAL
OVERHEAD PROJECTOR
SUPPLEMENTARY: DEMONSTRATIONS
CHALK BOARD
TAPES & RECORDS

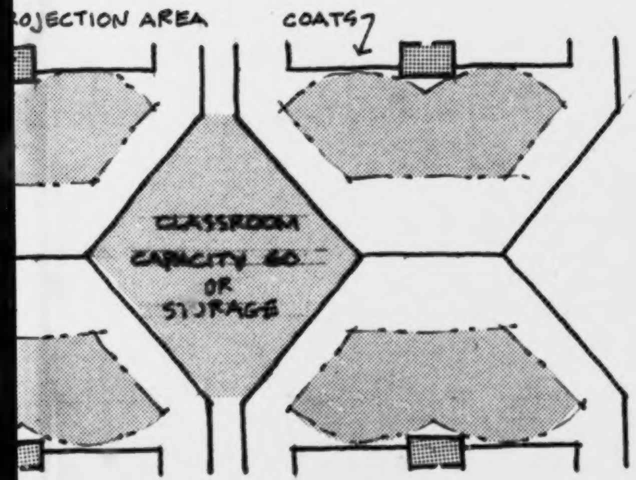
ACOUSTIC
HARD
ABSOR

F

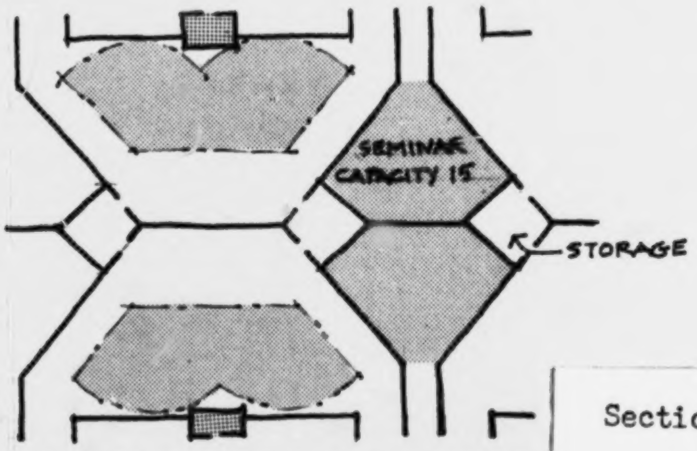

100
80
60
40
20
0
CAPACITY
TV CLASSROOM OR SEMINAR ROOM
CAPACITY RANGE 12 — 25
TV MONITOR
TION AREA
PROJECTION AREA
AUDIO
TV
ROLL DOWN SCREEN
FOR OVERHEAD PROJ.
CABINETS

SECTION A-A




OJECTION AREA
COATS
CLASSROOM
CAPACITY 60
OR
STORAGE

T PROJECTION ALTERNATE


SEMINAR
CAPACITY 15
STORAGE

Section 2

FRONT PROJECTION PLUS SEMINAR

## USTICAL TREATMENT

HARD REFLECTIVE CEILING PLUS
ABSORPTIVE MATERIAL ON REAR WALLS

## LIGHTING

TABLET SURFACES - RECESSED DOWN LIGHTS
GENERAL ILLUMINATION - PERIMETER COVE LIGHT
AUXILIARY - SPOTS ON CHALKBOARD AND
, INSTRUCTION AREA.

**Design Studies**

**SCHEME K**

Design Studies
## DESIGN ANALYSIS - SCHEME K

This scheme is designed to accommodate a group of approximately 70 students, viewing both projected materials and TV monitors as part of the instructional process. Since any seat in the room falls within desirable viewing ranges for both screens and one of the TV monitors, the room may function either as a television receiving room, a room for viewing projected materials only, or a combination of both. In addition chalkboard and tackboard space is provided across the front and on the splayed walls to accommodate more conventional uses.

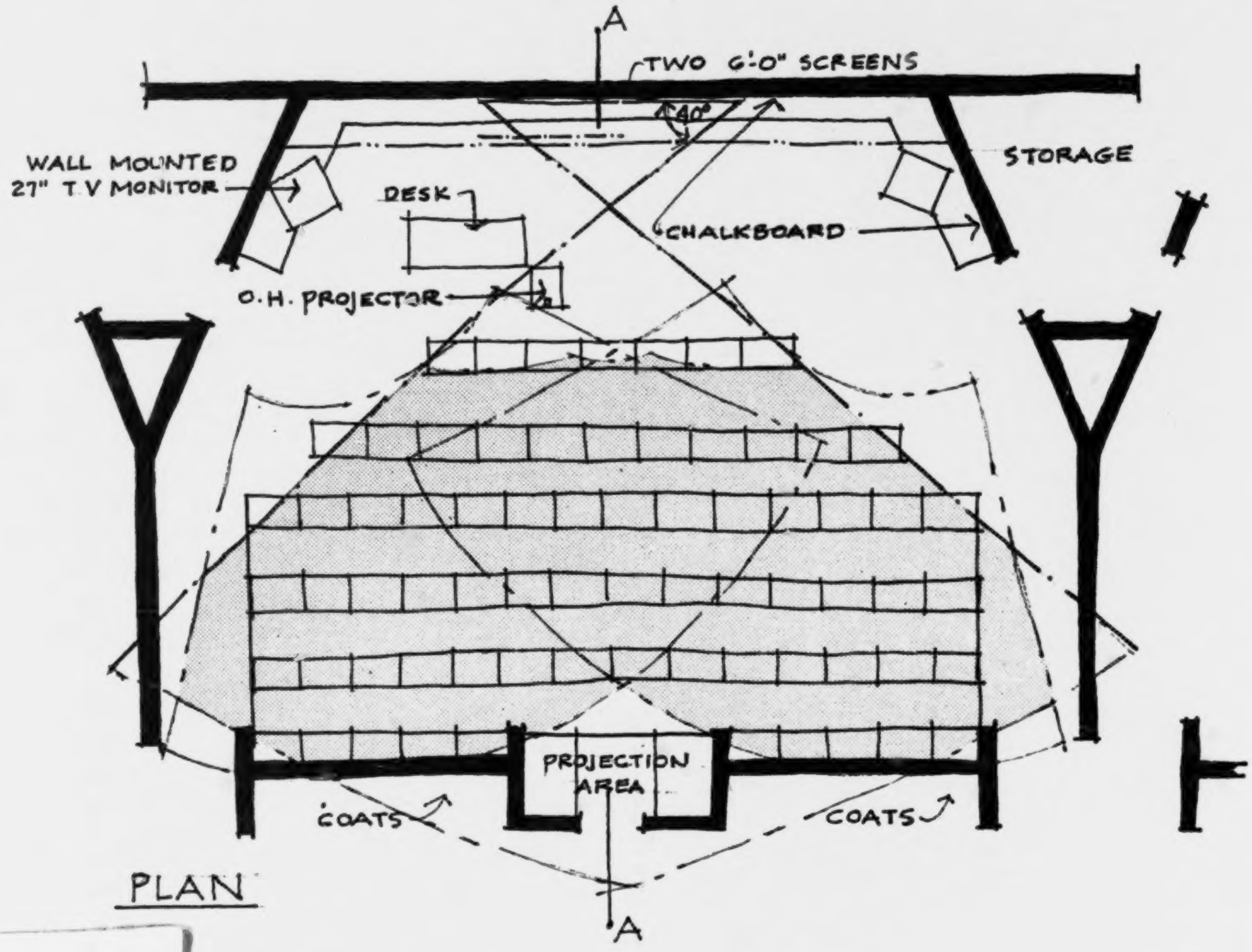
Projection equipment is located in a projection area accessible from a corridor, thus permitting materials to be readied while a class is in session. It is anticipated that all projection equipment will be remotely controlled, so an operator will not be necessary. A number of rooms, such as this Scheme K, could be served by a single technician who would ready the projectors as needed by each particular course and instructor.

Images are projected on two six-foot screens, allowing simultaneous projection of two images. One of the screens may be tilted for use with the overhead projector. Storage cabinets across the front of the room could contain two portable standby TV monitors, audio tape equipment, as well as materials and supplies needed by the instructors. The overhead trough across the front of the room contains the speakers for the audio system, display lighting for blackboard and tackboard surfaces, and possibly roll down maps, charts, or other display surfaces.

The three back rows of seating are elevated to improve viewing; the aisles at either end of the seating area are sloped. The seats should probably be fixed, and might best be pedestal-swivel seats at a continuous writing surface. If the 14-seat row (the maximum length permitted by many building codes) is not applicable, additional seats could be located at the end of each row.

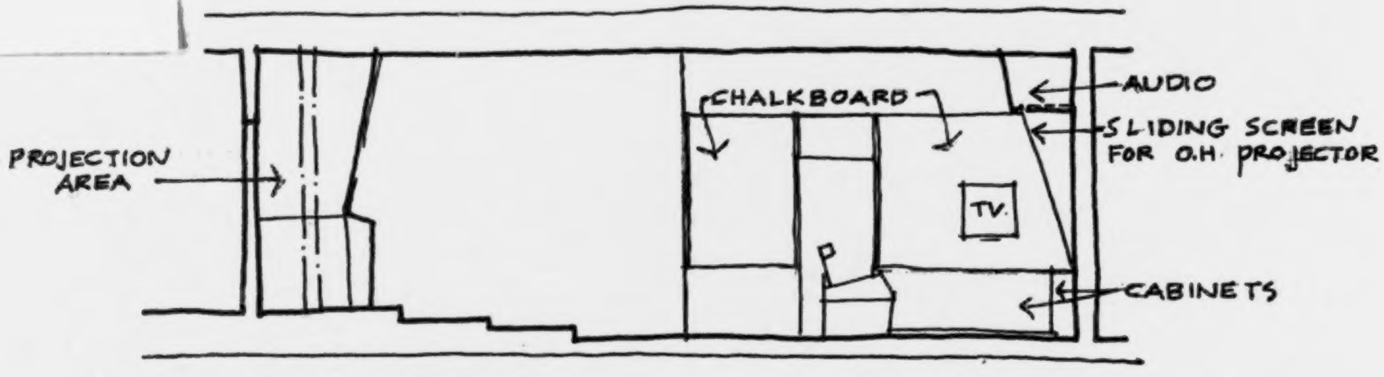
The triangular spaces towards the front of the room, formed by the splayed walls, serve as preparation and storage areas for adjoining rooms, and for mechanical ductwork. Coat space is provided by the recesses on either side of the projection center, and the entrance doors into this room are also recessed to avoid doors swinging into the corridor.

This basically rectangular scheme would work well in multiples, and could also serve as a basis for remodeling more or less conventional rectangular classrooms. When economical projected television is developed, the TV projector could also be located in the projection area and the two monitors might be removed from the room.

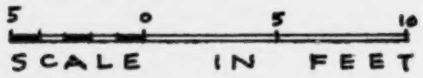

A
TWO 6'-0" SCREENS
40°
WALL MOUNTED 27" T.V MONITOR
DESK
STORAGE
CHALKBOARD
O.H. PROJECTOR
PROJECTION AREA
COATS
COATS
A

PLAN

Section 1


CHALKBOARD
AUDIO
SLIDING SCREEN FOR O.H. PROJECTOR
PROJECTION AREA
T.V.
CABINETS

SECTION A-A


5
0
5
10
SCALE IN FEET

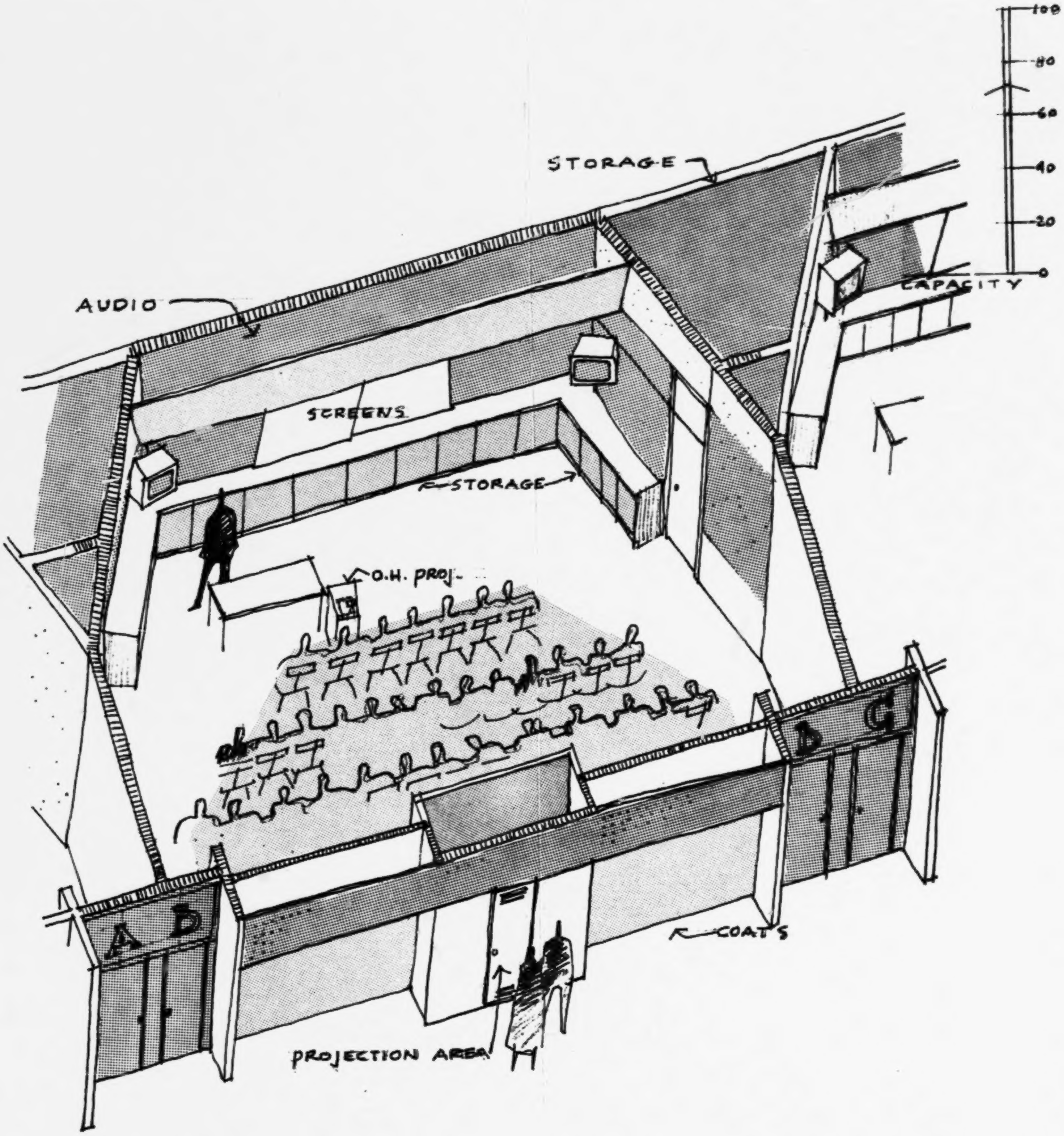
ROOM FUNCTION

VIEWING: T.V. MONITORS
FRONT PROJECTED MATERIAL
OVERHEAD PROJECTOR
SUPPLEMENTARY: DEMONSTRATIONS
CHALKBOARD
TAPES & RECORDS

ACOUST

HA
OF
AN

F


100
80
60
40
20
0
CAPACITY
STORAGE
AUDIO
SCREENS
STORAGE
O.H. PROJ.
A
B
C
D
COATS
PROJECTION AREA

K

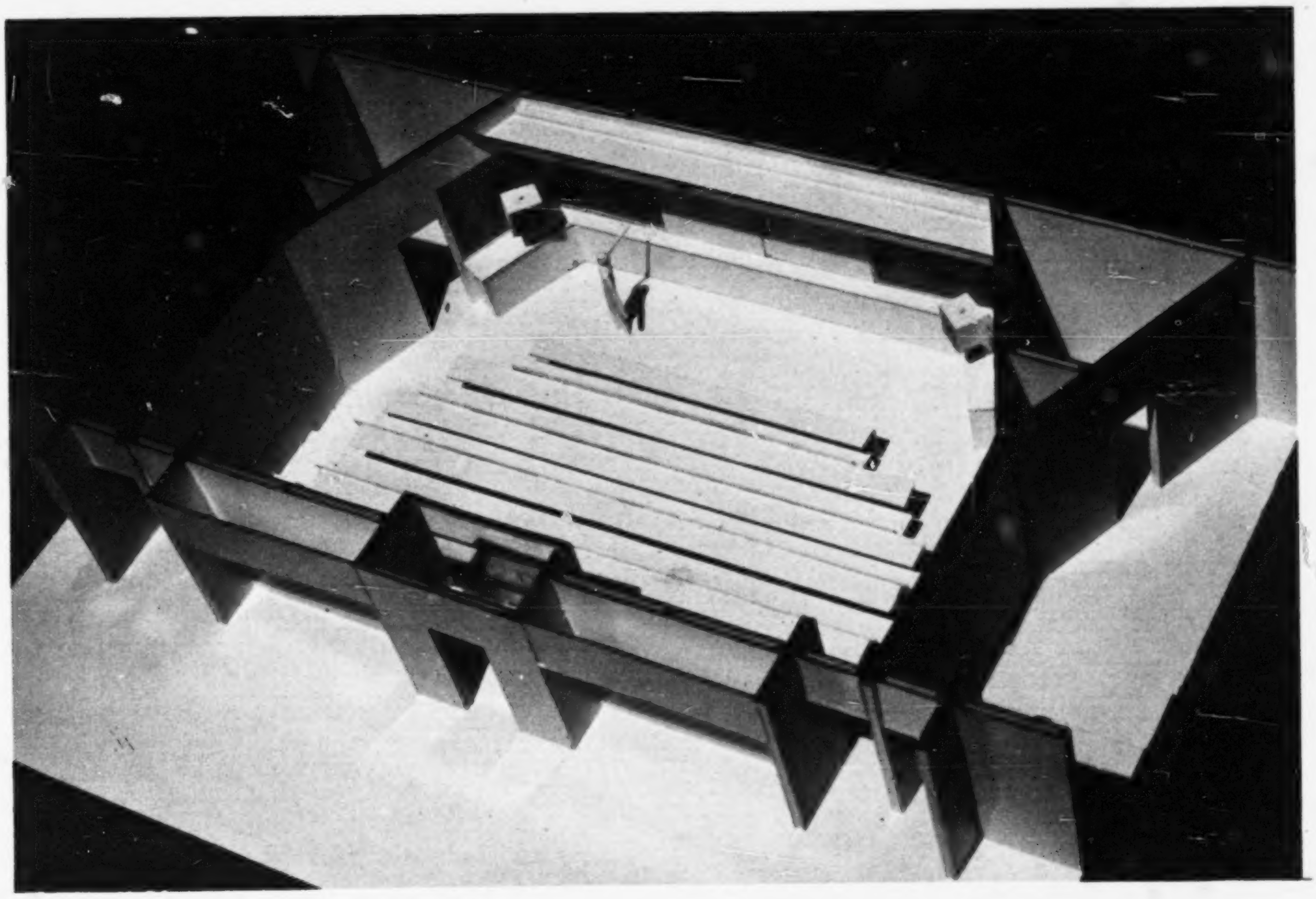
Section 2

### OUSTICAL TREATMENT

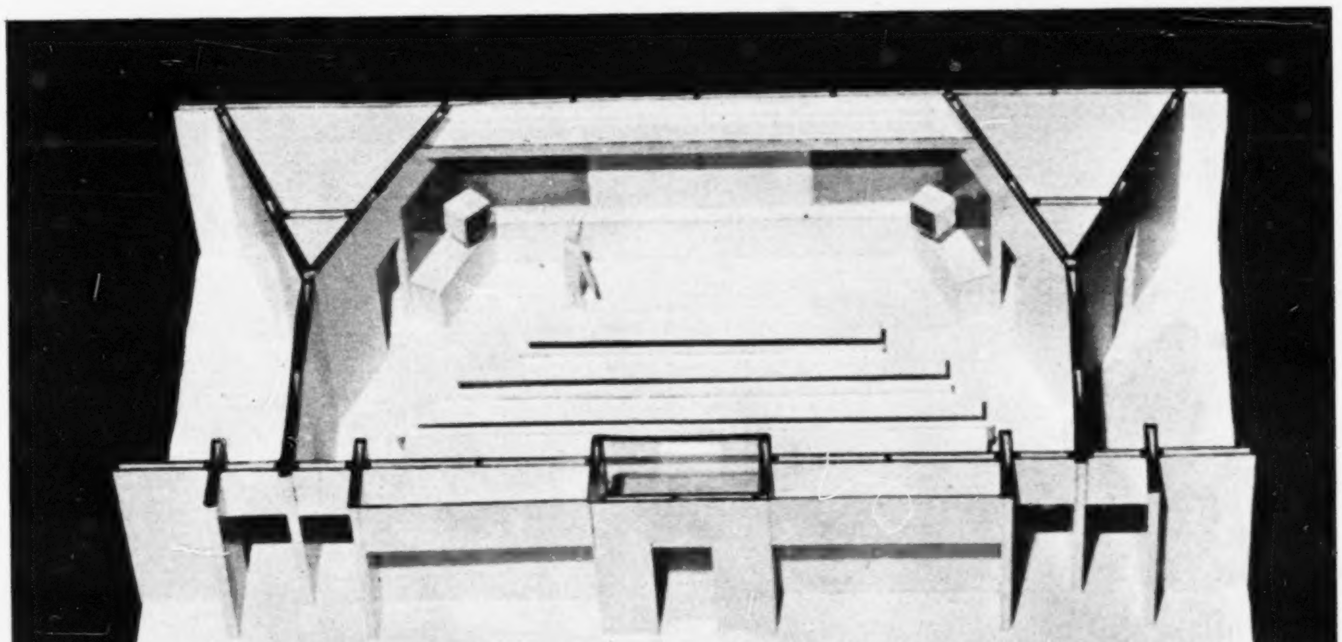
HARD REFLECTIVE CEILING PLUS 600□' OF ABSORPTIVE MATERIAL ON CEILING AND/OR REAR WALLS

### LIGHTING

TABLET SURFACES - RECESSED DOWN LTS.
GENERAL ILLUMINATION - PERIMETER COVE LIGHTS
AUXILIARY - SPOTS ON CHALKBOARD & INSTRUCTIONAL AREA



In addition to the drawings, a model was made of Scheme K. These two photographs of the model illustrate further the basic features of the scheme.



Design Studies

SCHEME L

## Design Studies
# DESIGN ANALYSIS - SCHEME L

This scheme for a small group learning space indicates alternative arrangements that would be feasible either in a new building or in remodeled space. A principal reason for dealing with a simple rectangular room was to investigate how best to utilize typical existing spaces.

For this scheme, the location of projection screens and TV monitor, in a diagonally opposite corner from the projectors, provides the most efficient use of space. It is noteworthy, too, that although the actual room size is arbitrary, a reasonably sized audience for one 24 inch monitor (35 to 40 students) is essentially a governing factor. This number can be accommodated adequately in a room 24 feet square, using tablet arm chairs. The optimum audience for viewing the four foot projection screens, only, would be a little larger.

Typically, because of economic considerations, the floor in such rooms will be flat, but an alternative stepped floor plan is also shown. The flat floor has the advantage of permitting rearrangement of the seating, if individual tablet arm chairs are used, but the stepped floor would provide better viewing. It is doubtful that stepping a floor need affect the ceiling height; ten feet is recommended as minimum in either case.

The "image-sound unit", shown in the sketches, suggests one way in which the screens, monitor, audio, and chalkboards may be organized as a preassembled equipment unit. Such a unit is not a critical essential of the plan, but if its elements are provided independently they should be similarly located in relation to the room. In either case, some storage area should be provided, which would house audio play-back equipment and probably a standby TV monitor.

As shown in alternate plan "A", a room of the same size and shape may be arranged for intra-group discussion sessions or seminar groups by using two concentric rows of fixed, but pivoted, seats at continuous writing counters. For such uses, the arrangement may include either two monitors as shown, or the "image-sound unit" may be used.

The shape of this scheme does not reflect an optimum viewing area as fully as Scheme M; as a result, the room is not as economical of space. If additional seats are used, they will not fall within the optimum viewing limits.

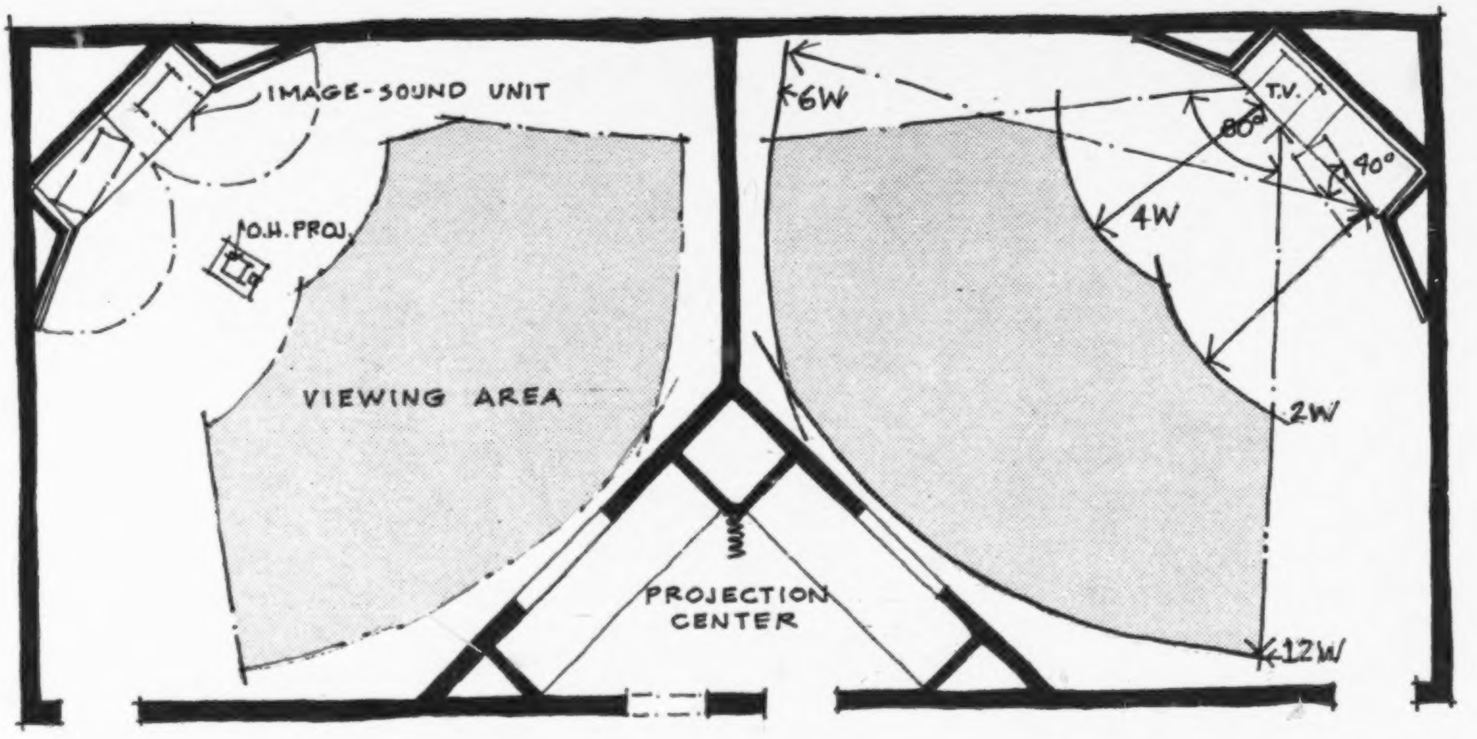
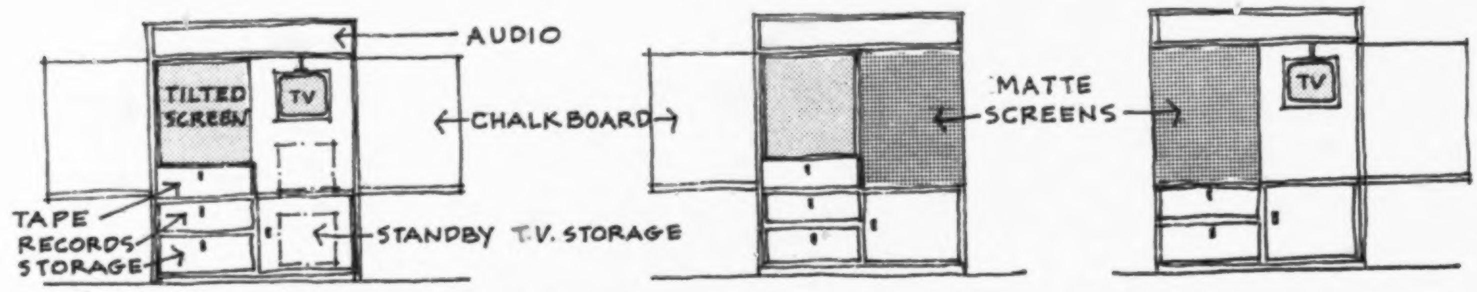


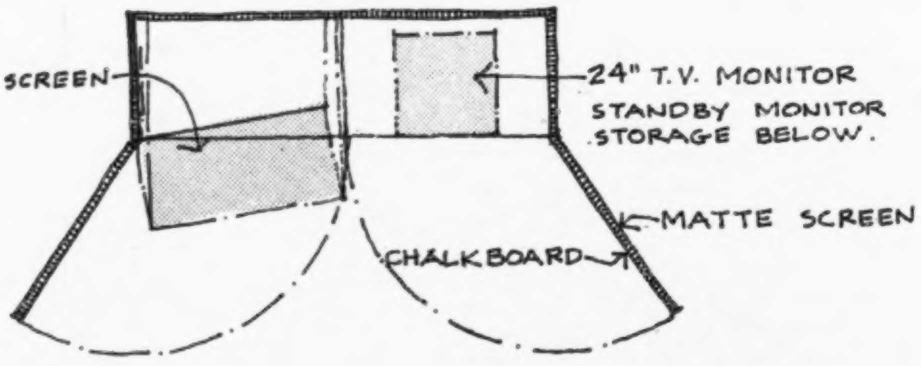
IMAGE-SOUND UNIT
O.H. PROJ.
VIEWING AREA
PROJECTION CENTER
T.V.
80°
40°
6W
4W
2W
12W
5' 0' 5' 10'
SCALE IN FEET

PLAN AND VIEWING AREA DIAGRAM


AUDIO
TILTED SCREEN
TV
CHALKBOARD
TAPE
RECORDS
STORAGE
STANDBY T.V. STORAGE
MATTE SCREENS
TV

ELEVATIONS - IMAGE-SOUND UNIT

Section 1


4'-0" × 4'-0" TILTED SLIDING SCREEN
24" T.V. MONITOR
STANDBY MONITOR STORAGE BELOW.
MATTE SCREEN
CHALKBOARD

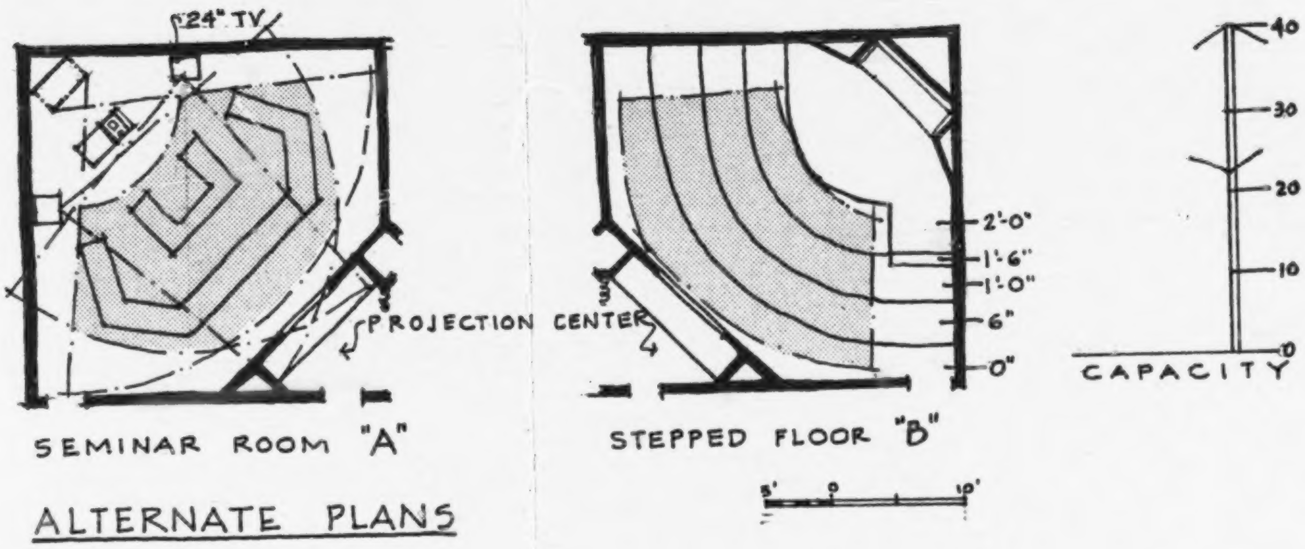
PLAN IMAGE-SOUND UNIT...

0' 5' 10'

ROOM FUNCTIONS

VIEWING: TV MONITOR
FRONT PROJECTED MATERIAL
OVERHEAD PROJECTOR

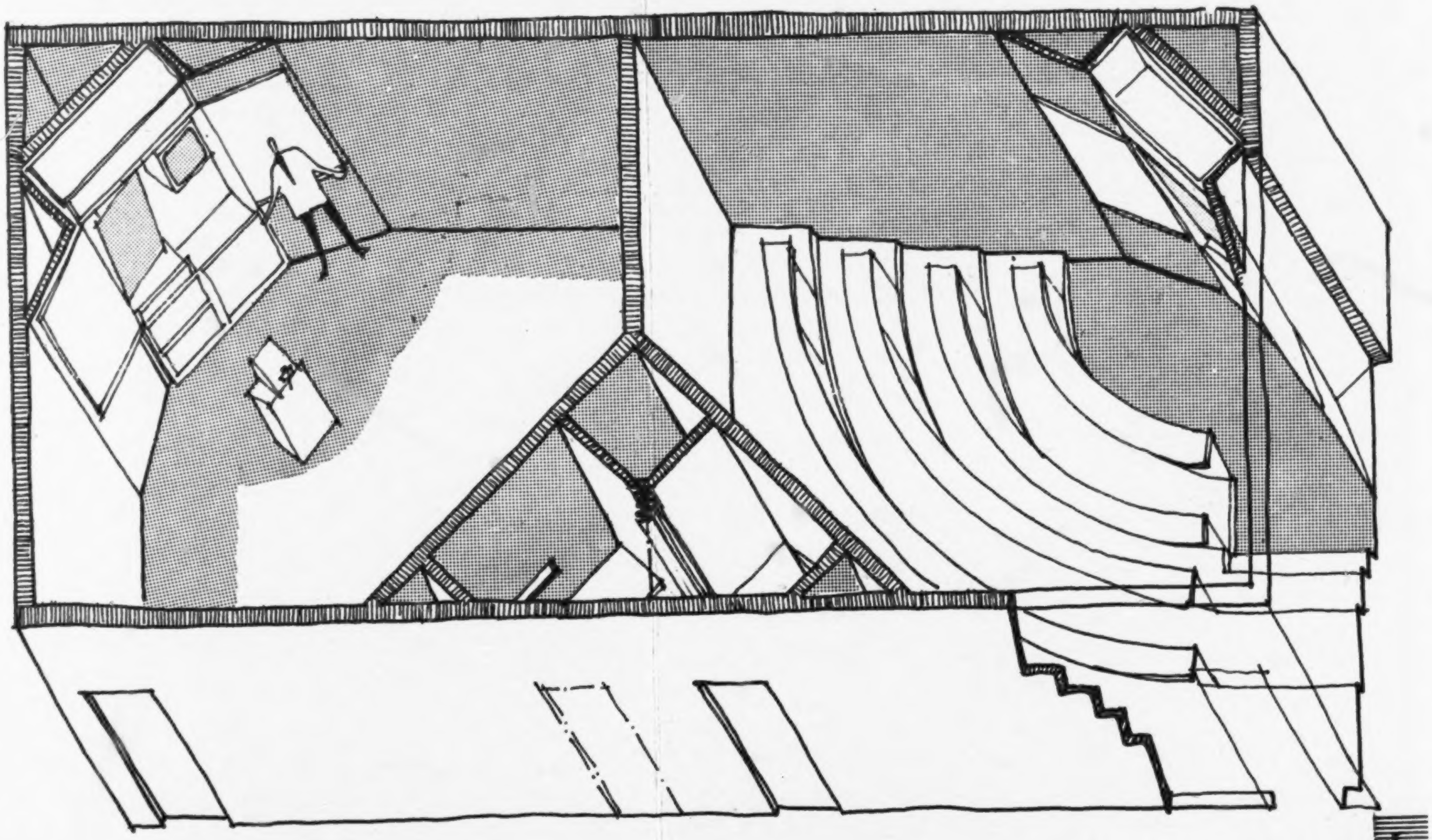
SUPPLEMENTARY: DISCUSSIONS W/ CHALKBOARD


24" TV
PROJECTION CENTER
2'-0"
1'-6"
1'-0"
6"
0"
40
30
20
10
0
CAPACITY
5'
0
10'

SEMINAR ROOM "A"

STEPPED FLOOR "B"

ALTERNATE PLANS



Section 2

## ACOUSTICAL TREATMENT

HARD REFLECTIVE CEILING PLUS 400$^{\square}$ OF ABSORPTIVE MATERIAL ON REAR WALLS.

## LIGHTING

TABLET SURFACES - RECESSED DOWN LTS.
GENERAL ILLUMINATION - PERIMETER COVE
AUXILIARY - CEILING SPOTS ON CHALKBOARD & INSTRUCTORS STATION

# Design Studies

# SCHEME M

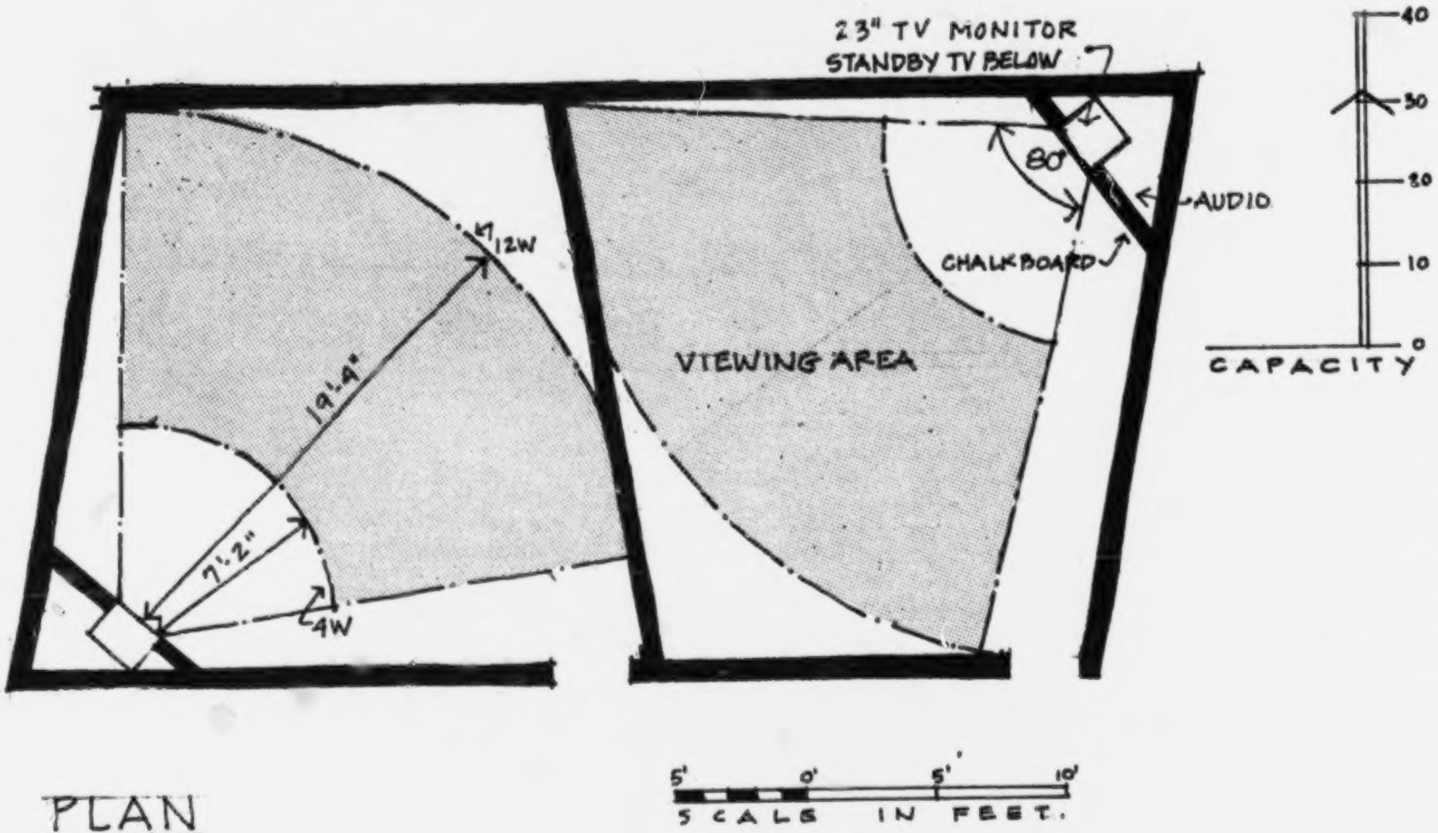
## DESIGN ANALYSIS - SCHEME M

With the growth of college instruction by television, it may be that an institution will find the need for a series of spaces in which a group of students viewing a single monitor is the primary function. The consideration of such a learning space is the basis of Scheme M.

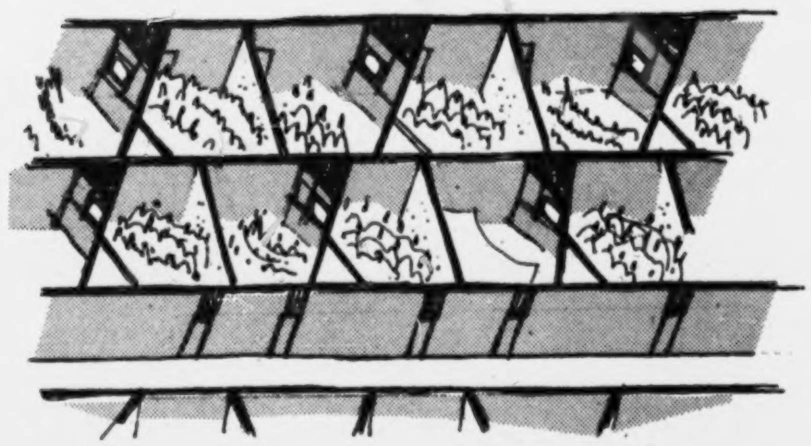
If the horizontal viewing angle is 80°, the minimum distance 4W, the maximum distance 12W, and a 23-inch TV monitor is used, the most economical shape, based on the resulting viewing area, is that shown by these trapezoidal shapes. Of course, if a larger monitor were used, the viewing area would be proportionately larger. With the 23-inch monitor as shown, the capacity would be 30 or 31 students.

In addition to the monitor, a chalkboard is included at one side which could be replaced by a tilting screen for use with the overhead projector. If an overhead projector were used, the seating capacity would be somewhat reduced in order to permit its location near the front of the room. Standby monitors for each room could be located in a cabinet beneath the permanently installed monitor, or several could be mounted on portable stands, stored in a central storage area, and wheeled into a classroom in the event of a breakdown.

The lower drawing indicates how a number of these spaces would fit together along both sides of a double-loaded corridor. The floors in the rooms might be either stepped or flat; in the latter case, and with the use of moveable seats, the seating could be rearranged easily into a seminar-type environment with television reception as a supplemental aid.


23" TV MONITOR
STANDBY TV BELOW
80°
AUDIO
CHALKBOARD
VIEWING AREA
12W
19'-4"
7'-2"
4W
40
30
20
10
0
CAPACITY
5' 0' 5' 10'
SCALE IN FEET.

PLAN



MULTIPLE UNITS.

ROOM FUNCTION

TV MONITOR VIEWING -DISCUSSION

LIGHTING

TABLET SURFACES -RECESSED DOWN LIGHTS
GENERAL ILLUMINATION- PERIMETER COVE LIGHTS
AUXILIARY - SPOTS ON CHALKBOARD

ACOUSTICAL TREATMENT

HARD REFLECTIVE CEILING - ABSORPTIVE MATERIAL ON REAR WALLS.

**Design Studies**

**SCHEME N**

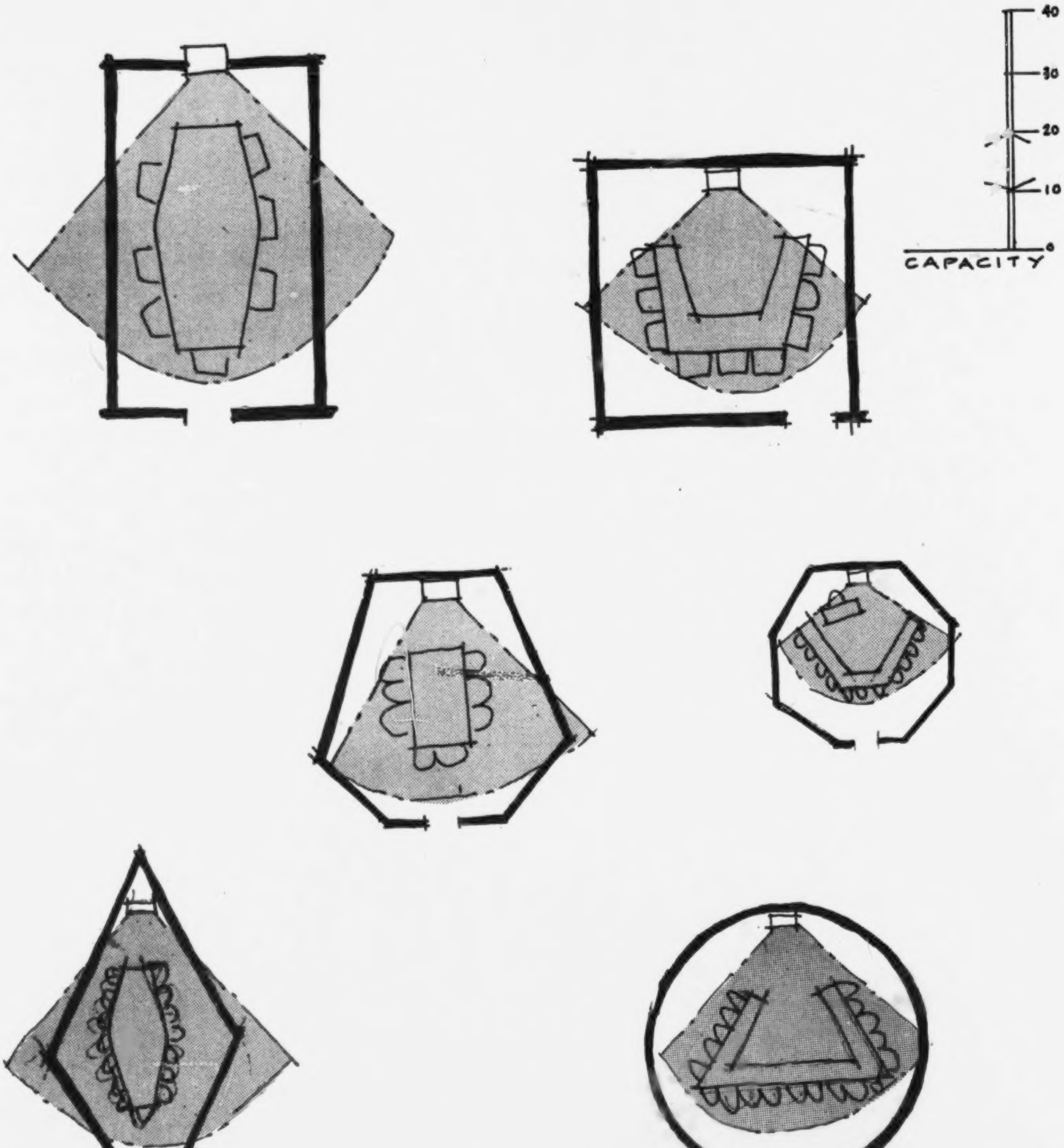
Design Studies
## DESIGN ANALYSIS - SCHEME N

This sheet of plans indicates various shapes for rooms in which seminar-type groups might meet, and in which limited use of some instructional aids is feasible. The capacities of such spaces will vary according to requirements of courses and methods, but will probably be in the range of 10 to 20 students.

The seating arrangement in the seminar rooms is, of course, the key to their design. A student should be able to readily face anyone in the room without having to turn completely around in his seat; at the same time the instructor must be in a position to direct and control the discussion when necessary. As long as the seminar-group, whatever its arrangement, falls within the optimum viewing area for any instructional aid, the inclusion of the aid is readily accomplished. However, if a number of aids are desired, which require several different types of projectors, the positioning of the equipment may become a significant problem.

A table surrounded by individual seats (which may be the rotating pedestal type) is probably the best approach to furniture if the room is always to serve as a seminar space. However, if other arrangements will be desired at times, moveable tablet-arm chairs might be better.

These seminar-type rooms might be used in conjunction with other types of spaces to provide a degree of flexibility of group sizes. One such possible arrangement is indicated in Scheme J, shown previously.


40
30
20
10
0
CAPACITY

VARIOUS SEMINAR ARRANGEMENTS - NOT TO SCALE

ROOM FUNCTION

SEMINAR WITH SUPPLEMENTAL INSTRUCTIONAL AIDS.

LIGHTING & ACOUSTICAL TREATMENT

DEPENDENT ON ROOM SHAPE

# APPENDIX

During the course of the project a quantity of reference and background material was gathered and compiled. In general, inclusion of all such material was not deemed necessary in this report. However, one exception is included.

The following is a compilation of the results of a questionaire-survey made by the Project Staff in the Spring of 1960. It was directed at the schools of engineering in the country to assess the current status of use of the aids and media, and the construction or renovation of facilities in which they might be used. The tabulation is of May, 1960.

A bibliography and additional data on the aids and media was compiled and is available in mimeographed form from the School of Architecture, Rensselaer Polytechnic Institute. Any inquiries as to methodology of the Project should also be directed to Rensselaer's School of Architecture.

Survey of Experience with and Facilities
for the Use of the New Instructional Aids
and Media in Schools of Engineering

Project DASFEE
School of Architecture
Rensselaer Polytechnic Institute

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Tabulation of the Results of a Mailed Questionaire

May 1960

| School | Enrollment in Engineering | Experience with Aids and Media | | Facilities Designed Specifically for Use of Aids & Media | |
|---|---|---|---|---|---|
| | | T.V. | Other | New[1] | Existing[2] |
| Air Force Institute of Technology | 272 | no | yes | no | no |
| University of Akron | 351 | no | yes | s | |
| Alabama Polytechnic Institute (Auburn) | 2098 | no | yes | | |
| University of Alabama | 1,300 | yes | yes | s | no |
| University of Alaska | 150 | no | yes | a,s,c | yes |
| University of Arizona | 1,800 | no | yes | a,c,l | yes |
| University of Arkansas | 1,100 | no | yes | c,l | |
| Bradley University | 840 | no | yes | a,c | |
| Polytechnic Institute of Brooklyn | | no | no | no | no |
| Bucknell University | 438 | no | no | no | no |
| California Institute of Technology | | no | no | no | no |
| University of California, L.A. | 1,641 | yes | yes | a,c | no |
| Case Institute of Technology | 1,600 | yes | yes | a | no |
| Catholic University of America | 600 | no | yes | no | no |
| University of Cincinnati | 1,600 | no | yes | no | no |
| The Citadel | 500 | no | yes | no | no |

| School | Enrollment in Engineering | Experience with Aids and Media | | Facilities Designed Specifically for Use of Aids & Media | |
|---|---|---|---|---|---|
| | | T. V. | Other | New[1] | Existing[2] |
| Clarkson College of Technology | 989 | no | yes | no | no |
| Clemson College | 1,800 | yes | yes | a,c,l | no |
| Colorado State University | 775 | no | yes | no | yes |
| Colorado School of Mines | 1,080 | no | yes | no | no |
| University of Colorado | 1,638 | yes | yes | a,s,c,l | yes |
| University of Connecticut | 1,520 | no | yes | no | no |
| Cooper Union School of Engineering | 360 | no | no | no | no |
| Cornell University | 2,300 | yes | yes | yes | |
| Dartmouth College | | no | yes | no | no |
| University of Delaware | 417 | no | yes | a | yes |
| University of Denver | 350 | no | yes | no (a,c,l | are now being designed) |
| University of Detroit | 1,402 | no | no | no | no |
| Drexel Institute of Technology | | no | yes | a,s,c,l | yes |
| Duke University | 500 | no | yes | no | no |
| Ecole Polytechnique | 1,268 | yes | yes | a | no |
| Fenn College | 750 | no | yes | a | |
| University of Florida | 1,034 | no | yes | no | no |
| George Washington University | 1,200 | no | yes | no | no |
| Harvard University | | no | yes | c,l | yes |

| School | Enrollment in Engineering | Experience with Aids and Media |  | Facilities Designed Specifically for Use of Aids & Media |  |
|---|---|---|---|---|---|
|  |  | T.V. | Other | New[1] | Existing[2] |
| University of Hawaii | 775 | no | yes | c | no |
| University of Houston | 1,550 | yes | no | c | no |
| Howard University |  | no | yes | no | no |
| University of Idaho | 650 | no | yes | no | no |
| Illinois Institute of Technology | 1,900 | no | yes | a,c | no |
| University of Illinois | 3,767 | yes |  | l | yes |
| Iowa State University | 2,765 | yes | yes | s | yes |
| Johns Hopkins University | 610 | no | yes | no | no |
| Kansas State University | 2,000 | no | yes | no | no |
| University of Kentucky | 1,400 | no | yes | no |  |
| Lafayette College | 600 | no | yes | no | no |
| Lehigh University | 1,500 | no | yes | no | no |
| Louisiana Polytechnic Institute | 973 | no | yes | no |  |
| Louisiana State University | 1,200 | no | no | no | no |
| University of Louisville | 700 | no | yes |  |  |
| Lowell Technological Institute | 1,750 | yes | yes | a,c,l |  |
| University of Maine | 1,100 | no | yes | large lecture room | yes |
| Manhattan College | 961 | no | yes | no | no |

| School | Enrollment in Engineering | Experience with Aids and Media |  | Facilities Designed Specifically for Use of Aids & Media |  |
|---|---|---|---|---|---|
|  |  | T.V. | Other | New[1] | Existing[2] |
| University of Maryland |  | no |  |  |  |
| Marquette University | 1,000 | no | yes | no | yes |
| Massachusetts Institute of Technology | 3,439 | no | yes | a | yes |
| University of Massachusetts | 870 | no | yes | c,1 | no |
| McGill University | 120 | no | yes | a |  |
| Michigan College of Mining & Tech. | 1,938 | no | no | no | no |
| Michigan State University | 1,780 | yes | yes | a,c | no |
| University of Michigan | 4,100 | no | yes | no | no |
| University of Minnesota | 3,070 | yes | yes | no | yes |
| Mississippi State University | 1,335 | no | yes | no | no |
| University of Mississippi | 362 | no | yes | no | no |
| Missouri School of Mines & Metallurgy | 3,000 | yes | no | no | no |
| Montana School of Mines | 317 | no | yes | a,c,1 | yes |
| Montana State College | 1,000 | yes | no | no | no |
| University of Nebraska | 1,384 | English | yes | a,s | no |
| University of Nevada | 360 | no | no | no | no |
| Newark College of Engineering | 1,400 | no | no | no | no |
| University of New Hampshire | 600 | no | yes | no | no |
| New Mexico State University | 950 | no | no |  |  |

| School | Enrollment in Engineering | Experience with Aids and Media |  | Facilities Designed Specifically for Use of Aids & media |  |
|---|---|---|---|---|---|
|  |  | T.V. | Other | New[1] | Existing[2] |
| University of New Mexico | 500 | no | yes | no | yes |
| N.Y. State College of Ceramics | 274 | no | yes | no | yes |
| City College of New York | 2,264 | no | yes | a | no |
| New York University | 2,000 | no | yes |  |  |
| North Carolina State College | 3,100 | yes | yes | no | yes |
| North Dakota State College | 1,100 | no | yes | no | no |
| University of North Dakota | 700 | no | yes | no | no |
| Northeastern University | 2,750 | no | yes | no | no |
| Northwestern University | 1,167 | no | yes | no |  |
| University of Notre Dame | 1,566 | no | yes | no |  |
| Ohio Northern University | 275 | no | yes | no | yes |
| Oklahoma State University | 2,775 | no | yes | a,1 | yes |
| Oregon State College | 1,581 | yes | no | s,o | yes |
| Pennsylvania State University | 2,850 | yes | no | s | yes |
| University of Pennsylvania | 1,375 | yes | yes | no | no |
| University of Pittsburgh | 2,315 | no | yes | yes | no |
| Pratt Institute | 525 | no | yes | no | no |
| Princeton University | 650 | no | yes | no | no |

| School | Enrollment in Engineering | Experience with Aids and Media |  | Facilities Designed Specifically for Use of Aids & media |  |
|---|---|---|---|---|---|
|  |  | T.V. | Other | New[1] | Existing[2] |
| Purdue | 3,960 | yes | yes | a,s,c,l | yes |
| Queens University | 1,000 | no | yes | no | no |
| Rensselaer Polytechnic Institute | 2,811 | yes | yes | a,s,c,l(proposed) | yes |
| University of Rhode Island | 610 | no | yes | no | no |
| University of Rochester | 259 | no | yes | no | no |
| Rose Polytechnic Institute | 400 | no | yes | no | yes |
| Rutgers University | 692 | no | yes | no |  |
| St. Louis University | 450 | no | yes | no | no |
| University of Santa Clara | 300 | no | yes | no | yes |
| University of South Carolina | 595 | no | yes | a | no |
| So. Dakota School of Mines & Technology | 850 | no | yes | no | yes |
| South Dakota State College | 775 | yes | yes | a,c,l | yes |
| University of Southern California | 743 | no | yes | no | no |
| Southern Methodist University | 654 | no | yes | no | no |
| Stanford University | 1,792 | no | yes | no | no |
| Stevens Institute of Technology | 2,100 | no | yes | no | no |
| Swathmore College | 100 | no | yes | no | no |
| Syracuse University | 1,372 | no | no | no | no |
| Agricultural & Mechanical College of Texas |  | no | yes | no |  |

| School | Enrollment in Engineering | Experience with Aids and Media | | Facilities Designed Specifically for Use of Aids & media | |
|---|---|---|---|---|---|
| | | T.V. | Other | New[1] | Existing[2] |
| Texas Technological College | 2,700 | yes | yes | s,c,l | yes |
| University of Toledo | 1,038 | yes | yes | s,c,l | yes |
| University of Toronto | | no | yes | c | no |
| Tufts University | 600 | no | no | no | no |
| Tulane University | 430 | no | yes | no | no |
| University of Tulsa | | no | yes | no | no |
| Union College | 300 | yes | yes | no | yes |
| U.S. Naval Postgraduate School | 785 | no | yes | no | no |
| Utah State University | 900 | no | yes | no | no |
| University of Utah | 1,250 | yes | yes | no | no |
| Valparaiso University | 365 | no | yes | no | no |
| Vanderbilt University | 574 | no | yes | no | yes |
| University of Vermont | 357 | no | no | no | no |
| Villanova University | 1,073 | no | yes | no | no |
| Virginia Military Institute | | no | no | no | no |
| Virginia Polytechnic Institute | 2,836 | no | yes | no | no |
| University of Virginia | 877 | no | yes | a,c | no |
| Washington University | 1,000 | yes | yes | no | yes |

| School | Enrollment in Engineering | Experience with Aids and Media | | Facilities Designed Specifically for Use of Aids & Media | |
|---|---|---|---|---|---|
| | | T.V. | Other | New[1] | Existing[2] |
| Washington State University | 1,150 | no | yes | no | no |
| University of Washington | 2,700 | no | yes | c | |
| Wayne State University | 1,600 | no | yes | no | |
| Webb Institute of Naval Architecture | 76 | no | yes | no | no |
| West Virginia University | 1,150 | yes | yes | c | no |
| University of Wichita | | no | yes | no | no |
| University of Wisconsin | 2,821 | yes | yes | yes | |
| Worcester Polytechnic Institute | 1,067 | no | yes | a,c,l | yes |
| University of Wyoming | 650 | no | yes | s,l | |

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[1] Built within last 5 years

[2] Remodelled to allow utilization of aids and media.

a - Auditorium
c - Classrooms
s - Studios
l - Laboratories
o - Other

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F

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